THE

FOUNDRY TRADE JOURNAL

WITH WHICH IS INCORPORATED

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NOTES AND COMMENTS.

The Foundrymen's Competition.

There still remains a fortnight in which competitors may submit papers. Up to now the response has been excellent. We wish to draw attention to the third rule of the competition, which states that the copyright of papers accepted for publication will become the property of the proprietors of THE FOUNDRY TRADE JOURNAL. The practical application of this will be that a limited number of papers will be chosen for publication, and will be paid for at ordinary contributors' rate of pay.

We are still receiving letters asking whether it will be in order to submit papers dealing with the melting and moulding shops only. We have previously pointed out that such matter must be accompanied by some explanation as to the position and size of the auxiliary shops, as when these matters are considered they might radically modify the design of the principal shops.

The Foundry and the Future.

Another step towards the restoration of pre-war conditions is the passing of the Excess Profits Tax. Owing to the low standard of profit existing in this industry in 1913-14, the foundry business has undoubtedly been severely penalised. Amongst the conditions accounting for the low status of the foundry in pre-war-time were three outstanding features. First was the fiscal system then in vogue, which allowed of unlimited foreign competition. The second feature was the inability to attract the notice of the enterprising financier, and the third the ease with which any recently opened market could supply itself with rough castings. As long ago as 1740 we were importing 20 per cent. of the iron consumed in this country from America.

Other serious depressions, resulting from war inflations, have been levelled by epoch-making inventions and developments along entirely new lines. The only innovation comparable with those resulting from the inventions of Huntsman, Bessemer, Siemens, Martin, Thomas, and Gilchrist would be a cheap process for the extraction of aluminium from clay. A reference to the composition of the earth's crust clearly indicates that at some future time aluminium must replace iron and steel. Already the work of Rosenhain and others have shown the possibilities of the metal when alloyed. Should the problem of the extraction of aluminium be resolved by the use in bulk of electricity, the workshops of the world would be transferred, when coal is worked out from their present positions, to mountainous countries or tidal rivers. This latter position is obviously conditional on the solution of another great problem, that is, the harnessing of the tide. To many critics who may remark that the foregoing is not helpful to them to overcome their present difficulties, and those likely to arise in the near future, our answer would be that by taking advantage of each innovation as it presents itself the foundryman can safely leave the future to itself.

The British Cast Iron Research Association.

We are asked by the Secretary of the Department of Scientific and Industrial Research to announce that the Research Association for the Cast Iron and Allied Industries has been approved by the Department as complying with the conditions laid down in the Government scheme for the encouragement of industrial research. As the Association is to be registered as a non-profit sharing company, the promoters have applied for a licence under the Companies (Consolidation) Act

THE FOUNDRYMEN'S COMPETITION.

FIFTY GUINEAS IN PRIZES FOR BEST DESIGN AND EQUIPMENT OF A FOUNDRY.

To mark the change over of the FOUNDRY TRADE JOURNAL from a Monthly to a Weekly publication, the Proprietors have pleasure in announcing that they are offering two Prizes of Thirty and Twenty Guineas respectively for an article dealing with the subject of the design and equipment of a Foundry (ferrous or non-ferrous), with special reference to the latest labour-saving devices and machines, internal transport and handling tackle

Competitors, by submitting articles, signify that they adhere to the following rules:—

(1) Competitors must be in the employ of an established British foundry subscribing to the FOUNDRY TRADE JOURNAL, or himself a subscriber.

(2) Articles must be illustrated with dimensioned drawing and sketches.

(3) The copyright of all papers and designs accepted for publication will become the property of the Proprietors of the FOUNDRY TRADE JOURNAL.

All papers must reach this office by Thursday, March 3rd 1921. The decision of the Editor will in all cases be final.

XUM

Buying Castings (III.).

The question of patterns intimately concerns the buyer, and apart from insisting upon an adequate supply being available, he must also give his attention to their upkeep. It is undoubtedly true that many indifferent castings may be directly traced to dilapidated patterns, and in his own interests, apart from the interests of the foundry, the buyer must formulate a system whereby all patterns are periodically overhauled.

Where the existing patterns are few in number, it is difficult to afford the time necessary for recalling and overhauling, without causing delay, and so long as no complaint is received from the foundry, the tendency is to leave the pattern where it is, even though the castings are criticised. Some founders, apparently with the desire not to offend the customer, will patch up an old pattern, but this eventually leads to trouble, and the better plan would be to advise the customer when the pattern is in need of repair. Should the buyer disregard this warning, then liability for indifferent castings will not subsequently rest with the foundry.

The buyer should, in the matter of patterns, be in close touch with the foundry, with a view to meeting its requirements. It may be that, for a certain part, but one or two patterns are available, and the part, being somewhat small, has to be accommodated to the best advantage. This means that it is used for "filling" a box, and consequently only a small number of castings are produced weekly. The buyer, unaware of the cause, is not satisfied with the delivery, and he is continually urging the foundry. If he is in touch with the foundry he will be able to ascertain the cause of the trouble, and arrange to supply sufficient patterns for a box, and thus ensure adequate supplies.

Having satisfied himself that sufficient patterns are in the foundries, the next thing is to see that these are in good condition, and it is advisable, therefore, for all patterns to be returned at the completion of the job. This is, of course, quite possible when an order is given covering a definite number of castings, and also when an open order is given for a specified period. In such cases the condition of the patterns is ascertained before they are sent to the foundry, and it can be determined whether these can stand up to the production demanded.

It is when repeat orders are given that the question of overhauling patterns is apt to be overlooked, for the new order is usually placed before the old one is completed, so as to ensure a continuity of supplies, and thus it is that a pattern is left at the foundry for six or even twelve months. On the one hand, this is gratifying to the founder who, knowing what he has to do, can arrange the work without trouble; but, on the other hand, he suffers when the pattern is in need of repair.

In this connection the buyer should have at his disposal spare patterns, the principle being that, whilst there is a sufficiency at the foundries, there is at least one set always in the factory. It does not mean that this one set is in the pattern store, for it may be undergoing repair, and when completed, is sent to a foundry and another set recalled. Such a system ensures that all productive patterns are in good condition, and this without any restriction of supplies.

Where the order covers a definite supply of castings, the pattern is recalled with the final delivery, and it must be inspected, and any repairs effected before being again put into commission. The buyer, desirous of placing a further order, gives due warning to the pattern maker, and the understanding is that, unless a notification in writing is given that the pattern is in good condition, no pattern is sent to the foundry. If this is adhered to, much trouble, delay, and expense is ultimately saved.

In the matter of dilapidated patterns the foundries are not wholly free from blame, much of the trouble being due to carelessness and rough usage. If a good pattern is sent, the buyer has the right to expect that this receives proper treatment, for patterns are expensive items, and cannot be supplied *ad lib.* at a moment's notice. Not only do they receive at times rough treatment at the hands of the moulders, but both before and after work their treatment leaves much to be desired. They are thrown about and bundled together—no system of storage in force, and, as a consequence, their life is materially shortened. It is not suggested that this state of affairs is general, but it undoubtedly does exist, and as the founder expects to be supplied with an efficient pattern, it is up to him to see that its efficiency is not impaired unnecessarily.

In the making of patterns, the buyer will undoubtedly benefit if these are strong and durable. Where but a few castings are required, there is a tendency on the part of the pattern maker to study economy by turning out a cheap pattern. This rarely gives satisfaction, and the best proves the cheapest in the end. Some firms arrange so that their patterns can be altered, one pattern being used for quite a number of parts, and so long as the pattern is altered correctly before despatch to the foundry, the result will be satisfactory alike to the buyer and the founder.

Where large quantities of castings are used, the question of plate patterns must receive the attention of the buyer, and wherever the opportunity occurs he should arrange for plate patterns to be provided. Most founders will draw the buyer's attention to this, definitely stating what reductions they are prepared to make in the matter of price. The buyer must bear in mind that, if he does not provide a plate, the founder will, and any advantage accruing from this falls to the credit of the founder, and not the buyer.

Some buyers are chary at providing plate patterns, because they feel that, the plate being made to suit the requirements of a certain foundry, it cannot be used elsewhere, and thus he is tied to one foundry. The higher cost of transit, too, has its effect, whilst the question of overhauling (and the expense of maintaining a spare pattern) is another deterring factor.

In regard to the first objection, it may be taken for granted that a plate pattern would not be made to a foundry requirement, unless the buyer is satisfied with the products of that foundry, and this being so, the chances of his transferring elsewhere are not great. However, should he desire to do so, the plate can usually be used elsewhere, for there is a certain amount of standardisation in foundries, although not so much as may be desired. If split patterns are used, and bolted on to a plate, any difficulty of transference is overcome, for the patterns can be detached from the existing plate, and placed upon another made to the new foundry's requirements.

In the matter of transit, the fact that changes are not frequent obviates any serious objection on this score, whilst the expense of making a spare pattern may be overcome by holding loose patterns in reserve instead. Thus, when the plate pattern is returned for repair, the loose patterns could be sent out temporarily, these also being used in the event of sample castings being required from another foundry.

A comprehensive pattern record should be kept by the buyer, so that he may know: (1) The total number of patterns; (2) whether these be on plate or loose; (3) the number of patterns at each foundry, and also the number in reserve; (4) the date each pattern was sent to the foundry; and (5) the date upon which the pattern was repaired. If this record is efficiently compiled, there is no fear of any pattern being overlooked, and a periodical recall follows as a matter of course.

Where a number of patterns are available for any one piece these should, if possible, be marked so that the imprint appears on the casting, so that the casting may be identified with a specific pattern. Thus, assuming that six patterns are in commission, distributed amongst, say, three foundries, these would be numbered 1, 2, 3, 4, 5, 6. Numbers 1 and 2 would be at one foundry, 3 and 4 at another, and 5 and 6 at a third, these facts being recorded by the buyer.

Thus, should trouble develop at a later date in regard to the castings, it is easy to determine from which foundry they came, and from which pattern they were made. The specific pattern can, if necessary, be recalled and checked, and any defect or discrepancy remedied.

It is observed that, although two patterns are identical in every particular, the castings often show a variation when the patterns are handled by different foundries. The castings received from "A" foundry, for example, may be perfectly correct, whilst machining troubles are experienced with the castings received from "B" foundry, even though no variation can be detected in the two patterns. This often arises from the tendency on the part of the pattern-maker to cut the machining allowance as fine as possible, and so cheapen the cost of machining and also that of the casting. It is to be feared that, very often, this proves more expensive, so far as the machining is concerned, for if the casting is slightly out of shape one dimension will not clean up, and to overcome the difficulty the machinist's setting up time is materially increased. It is more economical to give a fairly generous machining allowance, a fact which should commend itself to the buyer.

"A BUYER."

The exhibit of the Monometer Manufacturing Company at the coming British Industries Fair to be held at Birmingham from February 21 to March 4 should be interesting for foundrymen, as they propose to show pressure die casting machines for aluminium and white metal and their alloys, non-crucible tilting furnaces for iron, copper and other metals, and the Monometer hardening and annealing furnace. These exhibits will be found at Block "A," Stand No. 56.

The Wellman Bibby Coupling.

The essential pre-requisite for a shaft to run freely is that all the bearings should be in line. When a shaft has only two bearings this is easily attainable by ordinary good workmanship, but the difficulty of securing a true alignment increases when the shaft is long and more than two bearings are required, for, although the bearings may be in line when the plant is assembled, it generally happens that when under load the bearing supports yield or the bearings themselves wear unequally. The slightest want of alignment of the bearings puts a considerable stress on the shafts and increases the friction in the bearings, causing wear and loss of power. In the case of a motor directly connected to a machine any yielding of the machine bearings throws an undesirable load on the motor shaft and bearings.

In many machines vibrations and shocks are developed which should not be transmitted to the motor, and, to prevent this, a coupling is fitted which will absorb the vibrations and also compensate for want of alignment between the shafts, so that each shaft is free to rotate in its bearings. The flexible coupling employed should only transmit torsional forces; there must be no end thrust or pull between the shafts so that they can float to their free running positions. It should be possible to couple or uncouple the shafts in a few minutes by unskilled labour, and there should be no parts which can work loose under any circumstances. The coupling should have no unreliable element which might lead to breakdown, and the bearing surfaces should be large enough

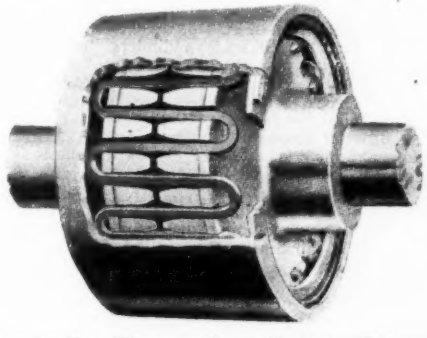

FIG. 1.—THE WELLMAN BIBBY FLEXIBLE COUPLING.

to ensure that there will be no wear after long continuous use.

Construction.—The coupling consists of two flanged discs (one keyed to each shaft), a tempered steel spring, in the form of a continuous cylindrical grid, and a shell, as shown in Fig. 1. On the outsides of the flanges there are large numbers of pitched cross grooves in which the spring is placed. The spring is the flexible member, and its shape, and that of the grooves, form the characteristic features of the coupling. The grooves in each disc widen towards those in the other, so that the spring fits closely in them only at their outer ends. There is a long free span of spring under light and normal loads which allows for considerable flexibility, but under heavy loads the span shortens as the spring bears farther along the grooves. No fastenings are needed to secure the spring.

The shell is a plain drum fitted with junk rings, which are kept in position by inverted piston rings sprung into grooves in the shell.

Flexibility.—The coupling will compensate for want of alignment of the shafts without setting up cross pulls as occur with leather belt types of coupling. The amount of eccentricity which the coupling will accommodate is more than that caused by worn bearings before requiring relining, or more than that by which the bearings are thrown out of line from expansion of casings in steam turbine drives.

Resiliency.—The design of the flexible spring member is such that the coupling has exceptional elasticity under all loads, which absorbs shocks and damps out vibrations on such drives as rolling mills, haulages, ram pumps and compressors. This is of special advantage as it protects the motor from the effect of these shocks.

The Inauguration of a New Foundry.

Messrs. James Evans & Company (London), Limited, whose works and registered offices are situated at Palatine Works, Worton Road, Isleworth, have recently put into operation a foundry, which is of great interest to the trade. This foundry is to serve as a demonstration works, so that any foundry contemplating extensions, can have extensive practical demonstrations of what the plant under consideration will perform. The production of this foundry will only supply their own needs, and will in no wise compete with other foundries, who should benefit by the lower cost price of the resulting foundry specialities.

The usefulness of such a plant was clearly demonstrated at the official opening, at which our representative was present. The first cast made in a new cupola of 36 in. shell diameter, produced 4 tons of very fluid metal, with an iron to coke ratio of 18 to 1. We consider we are justified in assuming that such a ratio could be normally increased to 20 to 1. The curious feature about this excellent result is that no special arrangement is incorporated, only common-sense design and manipulation accounting for it.

Another feature noticed by our representative was a fire-brick lined spark-arrester, which worked perfectly, and had the appearance of lasting as long as the cupola itself.

A series of moulding machines of various designs were demonstrated. In the future, the foundry manager will be able to assure for himself that the guarantee that a moulding machine can turn out a stated quantity of castings per diem is no "scrap of paper," but one he can prove for himself before purchase.

Such a foundry as Messrs. Evans have installed eliminates the otherwise necessity of introducing competitors or prospective competitors into foundries successfully working a foundry speciality.

Book Review.

"Foreign Trade Tables," by A. J. Lawson, M.Inst. C.E. Thomas Skinner & Company, Gresham House, Old Broad Street, London, E.C.2. Price 21s. net.

To any firm or person conducting foreign business this book, which is printed in Italian and English, should prove invaluable. Owing to our antiquated monetary and weights and measures systems, undoubtedly a quotation or price list on receipt by a foreign buyer has to undergo a series of mathematical gymnastics before it can be made comparable with those coming from our foreign competitors. The usefulness of this book is dual, so far as the Italian market is concerned, as the British manufacturer or exporter can readily, and with small chance of error, express himself in figures easily understandable by the buyer; on the other hand, should the book be presented to the customer he can himself expeditiously effect the necessary changes. The book is probably unique in so much as tables for the foreign exchange variations are included to supplement standard tables.

Publications Received.

"THE BULLETIN OF THE BRITISH ENGINEERS' ASSOCIATION" for January, 1921.

"UNITY," February, 1921. Messrs. A. H. Paterson, 64, Victoria Street, London, S.W.1. Price 2d.

"THE INDUSTRIAL LEAGUE AND COUNCIL JOURNAL for January, 1921, 82, Victoria Street, London, S.W.1. Price 6d.

"AVERAGE FIGURES FOR THE PERFORMANCE OF SOME DIFFERENT TYPES OF STEAM BOILERS." by David Brownlie, B.Sc., Messrs. Brownlie & Green, Limited, 2, Austin Friars, London, E.C.2. Price 2s.

"THE JOURNAL OF INDUSTRIAL WELFARE" for January, 1921. Industrial Welfare Society, 51, Palace Street, London, S.W.1. Price 9d.

"INDEX OF FOREIGN AND COLONIAL TRADE CATALOGUES." Department of Overseas Trade, 7-11, Old Bailey, London, E.C.4.

"THE IRON AND STEEL TRADES IN 1920." Messrs. William Jacks & Company, 5, East India Avenue, London, E.C.3.

Correspondence.

[We accept no responsibilities for the statements made, or opinions expressed, by our correspondents.]

"A MELTING PHENOMENON."

To the Editor of the Foundry Trades Journal.

To the Editor of The Foundry Trade Journal.

Sir,—I have read with interest the subject matter under the above heading which appeared in the February 3 issue of The Foundry Trade Journal, but do not think the explanation given by Mr. Blackiston is quite satisfactory.

The best of crucible steel melters has, unfortunately, from time to time a "runner," which necessitates pulling out the pot and allowing it to cool off. Careful examination of the partially fused contents of these pots reveals occasionally exactly the same phenomenon as that described by Mr. Blackiston

In an instance the writer remembers some little while ago a piece of ⅜-in. octagon chisel steel about 8 in. long was found with walls ¼-in. thick but which had had the whole of the centre fused away, whilst the outer surface was perfect. Now to account for such a phenomenon, in my opinion, there are at least three possible reasons:—

1. The piece was the crop end from a badly segregated bar.

2. It was sound, but had been decarburised on the surface; or

3. It was both segregated and decarburised.

In the first instance, melting of the centre may take place because of the lower temperature a segregated area containing high carbon, sulphur and phosphorus would melt at; whilst in the case of the decarburised bar melting of the centre may take place for the same reasons as suggested by Mr. Blackiston.

Assuming, therefore, that decarburisation may have been the cause of the phenomenon, what I would question is the mechanism of that decarburisation—it is suggested that this took place whilst the crucible was in the furnace. My opinion is that it did not take place at that time, but that the ingot or bloom from which the bar was forged or rolled was decarburised whilst heating up for this operation, or during a later heating; and that it is quite possible that the skin of the bar was almost carbonless and consequently had a melting point some 75 or 100 deg. C. above that of the inner metal.

Unless the charge in the crucible was exceptionally rusty and dirty, I think it is almost impossible for the general and uniform decarburising necessary to produce the phenomenon noted to take place.

Yours, etc.,

A. C. Hague,
Chief Metallurgist.

Cyclops Works, Sheffield.

EXTREMIST FALLACIES AND MISREPRESENTATIONS

To the Editor of The Foundry Trade Journal.

Sir,—In view of the constant references in your columns to the hampering effect on industry of labour unrest, it will probably interest your readers to hear that the Industrial Publicity Bureau, in whose founding and development I had the honour of taking an active part, is issuing for the use of employers of labour a series of short talks on industrial topics, which are printed in the form of little folders of convenient size to slip into the men's pay envelopes each week.

The first six of these little talks (we call them P.D.T.s—short for Pay Day Talks) have already been issued, and P.D.T.s will continue to be published every week, dealing in turn with every possible subject of interest to the working man in his relations with his employers and industry in general; particularly they aim at enlightening him in simple language on those economic laws, of which he feels the operation, but which he does not understand—such as the cause of high prices, unemployment, etc., and the results of strikes, "ca 'canny," and so forth.

This is the first national effort ever organised by the employers to show their employees "the other side of the picture." Leading industrialists are of one mind, that in this way, and this way only, can the insidious extremist and revolutionary propaganda, which is misleading and antagonising labour, and threatening the stability of industry, be counteracted. What we are doing is by means of P.D.T.s to educate the workers up to the employers' point of view, and their own best interests. That is of necessity the very groundwork of all efforts towards a good understanding between Capital and Labour.

The cost of operating the scheme, I might mention incidentally, is so small that there is no reason why every firm in the country should not participate. Any employer of labour wishing to see specimen P.D.T.s, and to receive details of the scheme, can do so by writing to me.

Yours, etc.,

Lewis E. Dickins.

11, Archer Road, Penarth, South Wales.
February 4, 1921.

The Efficiency Exhibition.

The Efficiency Exhibition, opened last Thursday at Olympia by Sir Robert Horne, President of the Board of Trade, indicates in a striking manner the present tendency to adopt efficient methods. The exhibits, which cover scientific, commercial, and industrial enterprise, include the following:—

The Polytechnic, London.—An assortment of dies produced in the engineering shops.

Hall, Lewis & Company, Cardiff, exhibit a 12 ton wagon, and an assortment of wagon accessories.

Turbine Patent Furnace Company, Limited, London.—A model of their Turbine Patent Furnace.

Firth-Brearley Stainless Steel Syndicate, Limited, Sheffield.—An exhibit of stainless steel products.

London Die-Casting Foundry Company, London.—An assortment of die-cast cylinders, crank cases, pistons, and other parts.

W. H. Dorman & Company, Limited, Stafford, show a variety of rock drills, riveters, etc., operated on the wave-transmission system.

The British Thomson-Houston Company, Limited, London, exhibit a quantity of electrical apparatus, including an electric rivet-heater and a portable X-ray outfit.

Loughborough College, Leicester.—An exhibit of engineering tools, including dies and vices, together with electrical apparatus constructed in the College laboratory.

Armstrong College, Newcastle.—This exhibit includes a number of specimens of iron ore, and Dr. Bedson's apparatus for determining the explosibility of coal dust.

The University of Sheffield.—An assortment of laboratory glassware, together wth specimens of dolomite, silica stone, silica brick, ganister, and corroded coke-oven brick.

British Oil & Fuel Conservation Company, London.—The "Precision" Temperature Control apparatus for maintaining uniform temperature in heat-treating furnaces.

Galvanising Equipment Company, Limited, Tottenham.—This exhibit includes a "Galeco" furnace, container, and separator, representing plant employed in the "Galeco" rust-proofing process.

The University College of Newcastle.—Various types of miners' safety lamps, and includes an exhibit by the Newcastle Benzole Company, Limited, who show a variety of coke-oven bye-products, and also an exhibit by Priestman Collieries, Limited, Newcastle, showing the production of coke from a given quantity of coal.

Skefko Ball Bearing Company, Limited, Luton.—This exhibit includes coal tubs fitted with ordinary wheels, and others fitted with Skefko ball-bearings, the difference in draw-bar pull between which is demonstrated by a weighted flexible wire passing over a pulley. The comparative test shows that it requires five times the weight to move one tub of coal fitted with ordinary wheels than is required to move two trams of coal fitted with Skefko ball-bearings.

MOULDING MACHINES.—At a recent meeting of the Newark Foundrymen's Association Mr. Edwin S Carman, of the Osborn Manufacturing Company, Cleveland, speaking on "Moulding Machines in the Jobbing Foundries," stated that on account of the high cost of timber, he advised the use of steel flasks, of few sizes and one of a size When buying a moulding machine, he cautioned against choosing one with working parts exposed to the sand. He said that with the best hand-ramming there would be soft and hard spots: that the moulding machine rams uniformly, and the moulds do not require venting.

Mechanical Tests for Cast Iron.—Part II.*

(*Continued from page* 134.)

By F. G. Cook.

A most desirable test for cast iron is for its *general* hardness—not surface hardness—or rather density, which for this metal is best described by Dr. Unwin as the resistance to penetration. The most handy and reliable form of test is therefore the drill test, as all the other methods previously mentioned deal with surface hardness only. As this test, like many other mechanical ones, is purely

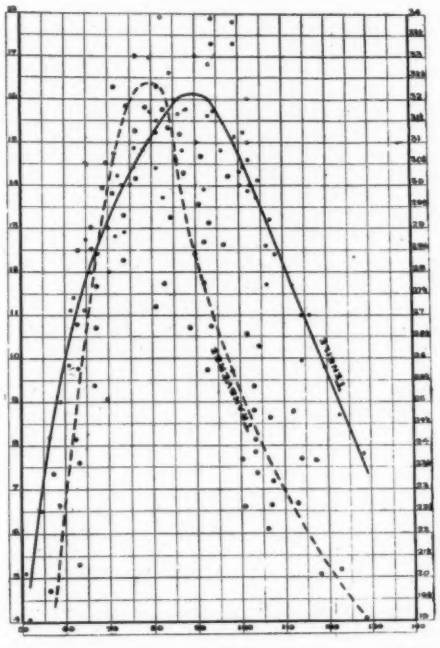

FIG. 1.—TENSILE AND TRANSVERSE TESTS ON CAST-IRON.

comparative, it matters very little, within reasonable bounds, as to the exact method adopted to take it, so long as they are repeated in each test The routine observed by the author has been to cast bars 1½ in. diameter of the metal to be tested, ⅛ in. shaped off one side to give a flat surface to work upon and remove the outside skin. Four holes, ¾ in. diameter, are then drilled to a depth of 1 in., the number of revolutions required to drill to this depth is noted, and the mean of the four holes is taken as indicating the general hardness. Points to be watched to obtain reliable results are that the angle of the drill is ground exactly the same for each test, which is arranged for by a suitable guide on the grinding machine. The result can also be influenced by the kind of drill used; it is therefore essential to keep the same drill for the purpose; in fact, two drills are used and two holes drilled with each, which minimises many discrepancies which otherwise might arise. The efficiency of drills is materially affected by the sharpness of their point, and as cast iron is often not homogeneous, and may contain more or less hard spots, a false result may be obtained owing to the point becoming unduly dulled by striking a hard spot in the early stages of the test; to avoid this a hole ⅛ in. diameter is first drilled, which affords clearance for the point of the drill and ensures the full cutting edge coming into operation. It is obviously necessary that the same weight be attached to the drill and also that it runs at the same number of revolutions per minute for each test. Mechanism for giving a diagram is also desirable as a guide as to whether abnormal hard places or hollow spaces have been encountered, both of which would give a false result.

This test represents more particularly the density of the metal, and it has previously been shown by the author that cast-iron samples containing much more of the hardening chemical elements had given lower test results than others containing less, this being explained by the fact that the samples containing the greater amount of combined carbon and sulphur, which had given low results, had abnormally large crystals and larger flakes of graphite, and were therefore not so dense.

This test also shows a marked relation between the hardness numeral and the relative tensile and transverse strength of the metal. Fig. 1, which is reprinted from the author's paper in 1910, gives relative results of over 70 tests, from which it will be noted that the tensile and transverse results increased with the hardness up to a point and then fell away again; it will also be noted that the *maximum* transverse test was obtained with metal a little softer than that which gave the maximum tensile result. The differences shown in these results, which were all taken with the same class of iron, is explained by the fact that the bars were cast on the castings, some of which weighed only a few hundredweights, whilst others were as heavy as two tons.

This diagram also explains a point which is very often raised, *i.e.*, as to whether a test bar will give better result if cast to size and tested with skin on, or if cast larger and machined to size.

In such a case the smaller bar, owing to the increase in the rate of cooling, will be harder and more dense than the larger. If the metal from which the bars are cast is such as to be too hard to give the best results, the smaller bar will be harder still and give still worse results, whilst if the metal is too soft the extra hardness and density of the smaller bar will give better results.

In connection with the Brinell form of hardness testing for cast iron, one of the objections lodged against it is the difficulty of measuring accurately the size of the indent; it was not uncommon for different readings to be taken of the same test on different days. To avoid this the British Chuck and Piston Ring Company, of Coventry, have invented a simple and ingenious device for their own use which is easy to manipulate and has the further advantage that the test is a mean of two specimens. By the courtesy of Mr. William A. Owbridge we are able to give the following particulars concerning it:—Fig. 2 shows a section of the container with the two test-pieces and the test-ball in position; it is so designed that the two outside faces of the test-pieces are directly parallel and also that the ball is kept central. After the container has been

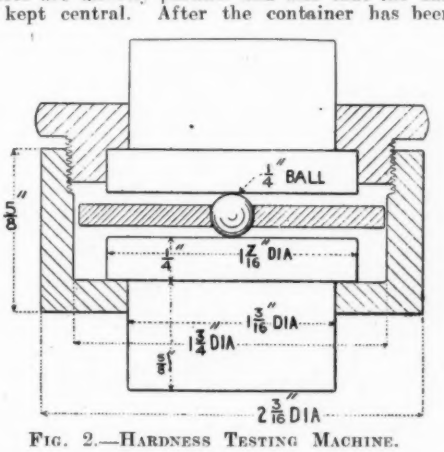

FIG. 2.—HARDNESS TESTING MACHINE.

screwed up tightly the length overall is measured by a micrometer, the whole is then put under a drop hammer, which weighs 56 lbs., and is allowed a drop of 18 ins. After the blow has been given the container is screwed up tightly to take up the indent made in the specimens and the overall

C

* Paper read before the London Branch of the Institution of British Foundrymen.

length again measured, the difference between it and the previous measurement being considered the hardness numeral.

Casting Temperature.—For many years foundrymen have been well conversant with the fact that casting temperature has a marked effect upon the physical properties of cast metals, but it was not until the important "Carnegie Research" of Dr. Longmuir that anything like exact results were obtained, many of which were certainly startling. In connection with the casting of high class metals there is undoubtedly a great need for a handy practical optical pyrometer. For small quantities of metal the "Foster" pyrometer, as used by the British Chuck and Piston Ring Company, is very convenient, but for large quantities of metal it is of very little use.

Low silicon cast iron is very prone to the effects of casting temperature, and some irons employed for such purpose are also liable to liquid contraction. A handy workshop test for casting temperature with this class of iron, which the author has used successfully for many years, consists in making bars of the general dimensions shown in Fig. 3. When cold the bars are broken through the line A.B., the condition of the fracture giving an indication of the temperature at which the metal was poured. Passing from the correct temperature—(which is usually as hot as can be obtained from the cupola)—to very low, the following fractures will be observed, perfectly solid and homogeneous, then slight whitish centre, then brown centres of varying sizes and depth of colour as temperature is lowered and then black centre. With

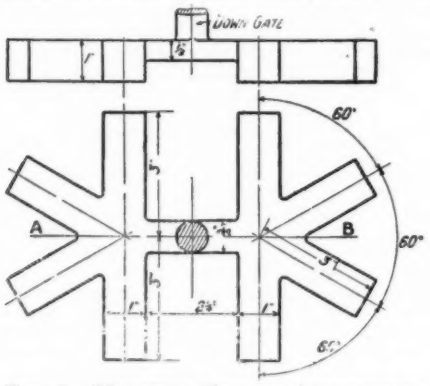

FIG. 3.—WORKSHOP TEST FOR DETERMINING CASTING TEMPERATURES.

the latter is always associated open cavities, and immediately above them is invariably found a gas hole.

The phenomena of these results formed the basis of George Hailstone's "Carnegie Research" of 1913, when he found that reduced casting temperatures resulted in larger plates and flakes of graphite, lower specific gravity, higher percentage of carbon dioxide, hydrogen and nitrogen and a decrease in the quantity of carbon monoxide in the gas evolved.

For softer cast iron, which can be cast at a lower temperature without suffering the same effects as low silicon irons, a test bar in the form of a wedge is a very useful guide as to the fluidity of the metal. Dimensions of such a test bar used by the British Chuck and Piston Ring Company are 9 in. × 1 in. × ⅜ in. thick at the largest end, tapering to 1-32 in. at the smaller, the bars being run from the thick end.

Cupola Blast.—The author has previously dealt with the effect of blast pressure upon the physical properties of cast-iron, and showed that every increased increment of pressure resulted in increased hardness of the metal. Since then a further research has been made to prove the effects of volume of blast upon cupola working,* when it was found that pressure not only has an effect upon the quality of the metal but also upon the quantity melted in a given time, the following formulæ for most efficient working being deduced:—

$$\frac{W\sqrt{P}}{D}=330$$

Where D = diameter of the cupola melting zone in feet.
W = quantity of air in lbs. per minute.
P = gauge pressure of air in ounces.

In every case where high class work requiring low silicon iron has to be dealt with, the cupola should be fitted with a recording blast pressure gauge and the revolutions of the blower should be capable of variation whilst at work.

Volume gauges are also now being made, notably Clarke's in America, and also a manometer gauge in conjunction with Petot tube by Messrs. Alfred Herbert, Coventry, but as the temperature of the atmosphere and height of barometer have a marked effect upon the accuracy of the readings, it is necessary to make corrections accordingly.

Impact Test.—Whilst impact testing is not usually applied to cast iron, it is, however, beginning to be used, particularly on the Continent, in connection with Diesel engine work. Whilst the Izod method of testing is more applicable to brittle substances, and should therefore be of use for cast iron, the practical limits as to the size of the bar is too low to give correct indications for this class of work. The sections of Diesel engine parts, particularly the piston heads, are very thick, and it is more advisable to test the metal under nearly similar conditions.

A satisfactory test is on 40 m/m (1.57 in.) square bars, supported on knife edges 160 m/m (6.3 in.) apart, and by dropping a weight of 12 kilos (26.5 lbs.) from a height of 30 c/m (11.8 in.), increasing the height of drop by increments of 5 c/m (1.9 in.) until such times as the sample breaks, the height at which the bar eventually fractures being taken as the impact figure. Attached to the weight, in such a manner as to strike the bar parallel to the supporting knife edges, and the centre of same, is another knife edge; the face of all the knife edges should be rounded 1-16 in. radius.

A result of 55 c/m (21.5 in.) is considered none too high for the work named, although this is quite a severe test. The maximum attained, as far as the author knows, has been 80 c/m (31.3 in.).

In conclusion, engineers who have no knowledge of the founders' difficulties are apt to dub the members of the trade as "non-progressive." The foregoing tests, all of which are in daily practice and do not exhaust the number employed, should serve to show that some progress and effort is being made to meet the ever-increasing exactions of engineering science, which are undoubtedly more severe to-day than at any previous period of history. The fact that the requirements are being met and the difficulties satisfactorily solved is the best answer to such an epithet. If engineers in general, and draughtsmen in particular, would strive to know something of even the laws of crystallisation much better results could often be obtained with infinitely more economical results and less anxiety to the foundryman.

* British Foundrymen's Proceedings, 1912-13.

Electric Rivet Heater.

A recent issue of "The Iron Age" describes a new type of rivet heater, which is being placed on the market by the Taylor Welder Co., Warren, Ohio. The machine is designed to heat two rivets simultaneously, although it can be built for any number of rivets in multiples of two. In most instances, however, a machine of this type will heat rivets sufficiently fast to keep one rivet boy busy removing hot rivets and inserting cold ones. The time required for heating a rivet ¾ in. × 4 in. is about 30 seconds.

The frame is made of angles and plates to reduce weight to a minimum, and so facilitate handling. It can be provided with tackle suitable for crane handling.

The outfit is equipped with a 15-kw. transformer, and a 5-step self-contained regulator for controlling and adjusting the heat for rivets of various sizes. Air is used for cooling the transformer. The current consumption is given as approximately 18 kw.-hr. for 100 lb. of rivets heated. Operation is by foot control thus leaving the hands free. A 6 × 16-in. rivet tray is placed in a convenient position to hold a quantity of rivets to be heated. The dies are 32 in. from the floor and the overall height is approximately 40 in.

NOBEL INDUSTRIES, LIMITED, are exhibiting at the British Industries Fair, which opens at Birmingham on the 21st inst., an interesting display of metals in various forms, alloys, thermit welding, etc.

An Electric Core-Oven.

Electric core ovens are being used in a few foundries with results that are said to have proved very satisfactory, and these results have led the Ohio Body & Blower Company, Cleveland, to place on the market a standardised portable electric oven for baking small cores, and to add to its line the manufacture of permanent electric core-ovens of larger capacities.

Some time ago this company brought out a portable core-oven for burning coal, coke, gas or oil, and the general design of the new electric oven is similar, so that one of its fuel-fired ovens can be converted to the use of electricity.

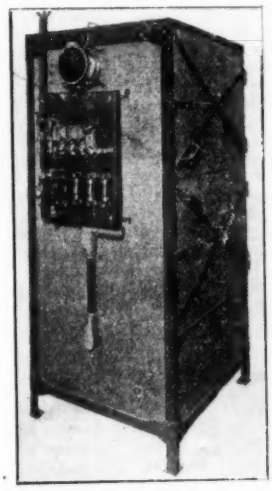

FIG. 1.—PORTABLE 18-KW. ELECTRIC OVEN FOR BAKING CORES. RATED TO BAKE 25 LBS OF MATERIAL PER KW.-HR.

The portable standard oven, as described in a recent issue of "Iron Age," is operated at a standard capacity of 15 kw., and it is stated that it will bake 25 lbs. of material, including shelves and core plates, per kw.-hr. The frame of the oven is light angles, and the walls are of 13-gauge galvanised sheet steel, the walls being insulated with $\frac{1}{2}$-in. air cell asbestos. The door is in two parts in order to avoid the loss of heat when the door is opened. The shelves are adjustable at 3-in. intervals. Pipe is supplied for six shelves. The oven is 6 ft. 8 in. high, outside dimensions, 37 in. wide and 34 in. deep. It is mounted on legs so that it can be moved around a foundry floor with a lift truck.

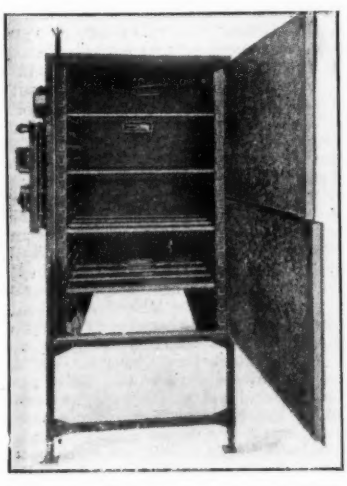

FIG. 2.—PORTABLE 15-KW. ELECTRIC OVEN SHOWING DOOR IN TWO PARTS.

The electrical equipment includes six 2½-kw. heating units located in the bottom of the oven and a panel on the left side. Above the panel is a thermostat which, operating through relays and switches, automatically controls the temperature between a pre-determined maximum and minimum. The current used is 220-volt, 3-phase, 60-cycle.

It is pointed out that with the use of the electric oven a uniform heat is assured, and that, consequently, the oven is particularly adapted for baking delicate cores, or cores that need to be baked uniformly all through. Other advantages claimed for the oven are that it requires practically no attention, all that is necessary being to turn on the switch and it provides a maximum efficiency.

The oven is also designed for mould drying and for japanning. When used for japanning provision is made for exhaustion of fumes, to avoid danger of explosion. Otherwise, only a natural draft through a 6-in. flue is required. The fuel-fired ovens of the same general design can be converted any time into an electric oven by removing the fire box, or burners, and replacing the steel plate at the bottom of the oven and the lower plate at the front with insulated sections, and adding the panel and heaters.

The electric heaters can be applied to standard permanent core ovens up to 220 kw. capacity per oven, and the company will build special electrically heated permanent ovens. In the large oven an exhaust fan will be provided for re-circulating the heat.

Carnegie Steel Company Works Schools.

The advantages of a course of technical instruction in all phases of the manufacture of steel to all its workmen not technically educated is now universally accepted. The Carnegie Steel Company have already started what are known as works schools at the Homestead and other works. The course covers two years, and beginning with a brief preparatory period devoted, if necessary, to a study of the essential laws of physics and chemistry, it covers all the metallurgical processes used by the company. The preparatory period is varied to suit the education of the students on entering the course. One of the objects in starting these schools was to bring within easy reach of deserving and ambitious employees, who through force of circumstances have not been able to attend technical courses, some of the advantages of a college education combined with a practical knowledge of the metallurgy of iron and steel. Prof. John L. Acheson, formerly of the staff of the University of Pittsburgh, was selected for the position, and is assisted by the superintendents and other technical graduates associated with the works.

A central school being impracticable, each plant has its own school, the management of which comes under the jurisdiction of the plant superintendent. The superintendent appoints a committee, composed of department heads and technically educated employees, to conduct the general business of the school in co-operation with the instructor. Each plant has a lecture room, which is furnished and equipped according to the wishes of the instructor and the requirements of the course. No tuition is charged, nor are the students required to spend any money for supplies, except for a special text book, which is supplied at the cost of printing. Any other books the student may wish to buy are also supplied at cost. For all time spent in attending the lectures the men are allowed full pay. Little knowledge beyond an elementary school education is required for the course. The company is endeavouring thus to remove as many restrictions as possible, and to present impartially to all its employees an opportunity to learn the reasons for the practices of the works.

While the schools are separate units as to the details of their management, they are also bound together as a unit in aims and ultimate results. This union is brought about by having but one supervising instructor, and by union meetings of the various committees. These meetings give opportunity for contact with the officials of the company, who may meet with the committeemen and discuss matters of policy pertaining to the general conduct of the schools

BEARINGS FOR HOT ROLLS. — Mr. Chas. Vickers, in a recent issue of "The Foundry," recommends as an alloy suitable for bearings for hot-plate rolls:—Copper, 77 per cent.; phosphor copper, 3 per cent.; tin, 10 per cent.; lead, 10 per cent. This forms the standard phosphor bronze for high-speed and heavy pressure, and is extensively used for bearings subjected to shock and vibration, heavy work and high speeds, such as crank pins, roll necks, bridge bearings and other bearings.

PROTECTING ALUMINIUM AND ITS ALLOYS FROM CORROSION.—To protect aluminium and its alloys against corrosion, M. Grotthuss has developed a new method, which consists in suspending the castings of aluminium in a bath, maintained at 60 deg. C., and using sulphur and molybdenum as electrolite and zinc as an anode. The castings quickly became covered with a dark brown coating, sufficiently durable to withstand working, bending or rolling. As a test, a treated casting was immersed in salt water for two months without showing the least sign of corrosion.

XUM

Structural Changes in Silica Bricks.*

Most of the silica-bricks made in this country are employed for the construction of steel furnaces, and the following remarks relate, except where otherwise stated, to bricks so used. A certain number are used for lining soaking pits and electric furnaces, but by far the greater part is consumed in the construction and repair of acid and basic open-hearth furnaces; in both of which, with minor exceptions, the whole of the structure exposed to the gases is built of silica-brick. The temperature of the flame itself has been estimated to be in the neighbourhood of 1,700 deg. C. to 1,800 deg. C., while the temperature attained on the interior surface of the furnace is generally believed to be about 1,600 deg. C. to 1,650 deg. C., but an accurate estimate is difficult on account of the strongly reflecting nature of the surface. Since these temperatures lie very close to the melting range of silica-brick it will be seen that a brick, maintained at the full heat of the furnace, would possess little or no rigidity even if it could be protected from the action of foreign matter carried by the gases. A most important part of furnace design is therefore the efficient cooling of the structure, so that the hot zone is restricted as far as possible to the inner surface of the brickword, while the structural stresses are borne by portions of the brick which are generally far below the softening point. With every precaution, however, the inner surface is slowly corroded by a constant fluxing action, and no portion of the lining is permanent. The life of the structure at any part depends on the temperature and on the degree to which the bricks are exposed to the fluxing compounds borne by the furnace gases.

Probably the bricks which form the wall separating the air- and gas-ports are those which are subjected to the highest temperature. The wall is necessarily thick, it is exposed on three sides to the burnt gases leaving the furnace, and has a corresponding small cooling surface. It is not necessary to discuss the numerous devices that have been proposed for the extension of the life of the structure at this point, but it should be observed that here, rather than in the roof or walls, the strength of the brick at high temperatures becomes an essential factor in the durability of the furnace.

Beside the silica-bricks in the furnace-lining itself, a considerable quantity is used in the chequer work of the regenerators. The difficulties here centre mainly in the accumulation and corrosive action of foreign matter, for except in the uppermost courses the temperature is well below the softening-point, and bricks of inferior quality can be used. The service of the regenerators is normally determined by the choking of the passages and does not depend on the refractory property of the bricks used. In the case of silica-bricks in the furnace-lining, so important is corrosion that refractory characters again play but a subordinate part.

Changes in Bricks.—The heat-alteration of a silica-brick at a moderate temperature represents simply the extension of changes initiated in the burning operation as already described. When the temperature exceeds 1,470 deg. C., the tridymite ground-mass and the ganister fragments ultimately become converted into a granular aggregate of cristobalite. In this condition the brick retains rigidity under moderate stresses. Thus even the "bank" of a steel furnace and the brickwork between the ports retain their shape. As the temperature increases above the transition-point, the fluid areas expand, owing to the solution of the cristobalite, until, at a temperature that depends on the amount of impurities present, the whole structure becomes fluid, and all rigidity is lost. The purer the brick, the higher is this temperature; but in no case can the structure remain rigid above 1,710 deg. C., the melting point of pure cristobalite.

Attention is directed to an apparent anomaly in the behaviour of silica bricks, which is to a great degree the basis for the divergence of views between certain workers as to the real existence of the 1,470 deg. C. transition-point. It has been observed that bricks heated to temperatures above the transition-point exhibit, on cooling, the ordinary tridymite network. This structure is well seen in the bricks used as a protective tier in the kilns, and which have been repeatedly burnt at the highest temperatures. Whether the normal kiln temperature is to be regarded as exceeding 1,470 deg. C. or no, there can be no doubt that in laboratory tests the transition point has been exceeded without the development of cristobalite.

ANALYSES OF USED ROOF BRICKS.

Acid Furnace.

Zone.	SiO_2	Fe_2O_3	FeO	Al_2O_3	CaO	MgO	Mn_3O_4
A (cristobalite)	79.60	13.62	5.73	0.80	0.10	trace	0.29
B (tridymite)	74.76	19.03	4.47	1.10	0.30	trace	0.28
C (transition)	91.00	2.51	—	2.70	3.35	0.05	0.19
D (unaltered)	95.30	1.27	—	1.10	1.90	trace	0.20

E. Rengade, Anal.[1]

Zone.	SiO_2[2]	Iron as Fe_2O_3	Al_2O_3	CaO	MgO	MnO
A (cristobalite)	84.62	14.1	0.60	0.35	0.03	0.30
B (tridymite)	73.80	24.7	0.70	0.50	trace	0.30
C/D greenish	85.73	7.6	2.40	3.80	0.12	0.35
C/D yellow	95.50	1.0	1.60	1.80	0.10	trace
D slightly stained	95.60	1.2	1.60	1.45	—	0.15

J. H. Whiteley, Anal.[3]

[1] E. Rengade, *Comptes Rendus*, vol. 166, 1918, p. 779.

[2] Silica by difference.

[3] J. H. Whiteley. Analyses made in order to locate more precisely the region of lime enrichment, and privately communicated for publication in the present memoir.

Corrosion of Brickwork.—In open-hearth steel-smelting furnaces the foreign matter introduced as flue dust from the gas-producers is negligible in comparison with the amount of iron oxide that is emitted from the bath itself. As the temperature of the furnace rises after melting down, a rapidly increasing amount of pure iron oxide is carried as a fine mist of liquid particles in the outgoing gases. This would seem to be an essential feature of the reaction; it is at a maximum during the "boiling" period and diminishes towards the finish when the carbon is low. This oxide penetrates to every part of the gas-passages and causes a rapid corrosion of the brickwork round the ports and in the uptakes where sharp changes in the direction of the gas cause the heavier particles to be projected against the walls. The greater part of it ultimately lodges in the chequer-chambers, where it gives rise to difficulties which, however, are not concerned with the refractory character of the brick there used. In an acid furnace the corroding agent is pure iron oxide and not slag or ore accidentally projected, but in the basic process a certain amount of lime is swept away in the gas and contributes to the corrosion, as will be seen above from the analyses of roof bricks. Locally, one of the most damaging actions is the casting of dolomite upon the banks in such a way that it falls above the port of the furnace built of magnesite bricks and comes into direct contact with the silica walls.

The lining of a furnace may be regarded as made up of a succession of zones—composed of fused matter, cristobalite, tridymite, and then unaltered brick—which vary in thickness in different parts according to the efficiency of cooling and the degree of attack by foreign matter, but which are generally similar in character throughout the furnace. A roof-brick may be taken as illustrative of the alterations met with in other parts of the structure.

* Extract from the Special Reports on the Mineral Resources Great Britain. Memoirs of the Geological Survey. Vol. XVI.

Influence of Gas-conditions on the Corrosion of Silica-structures.—The proportion of ferric oxide present in a melt at high temperatures is dependent on the composition of the melt, on the composition of the surrounding gases, and on the temperature. In the furnace chamber itself the surface-layer is exposed to burnt gases and is very hot; a considerable amount of the iron will probably be present as FeO. In the surface-layer of the uptakes the temperature is perhaps somewhat lower, and certainly the proportion of iron is greater. Here, however, the conditions differ essentially between the air- and gas-passages, the latter being corroded at a considerably greater rate. This is probably due largely to the fact that in the presence of a reducing gas much of the ferric oxide in the melt is reduced, with the formation of fayalite ($2FeO.SiO_2$). This compound has a marked "thinning" action on the fused layer, which consequently is able to penetrate and attack the brick at a greater rate.

A similar condition must be taken account of when considering attempts that have been made to produce a brick with iron oxide as an essential constituent. Such a brick can be heated (presumably under oxidising conditions) to a temperature that approaches the softening point of a pure silica-brick, and at lower temperatures is quite strong, no doubt because much of the iron is present as magnetite. In a reducing atmosphere, however, the brick will become heavily slagged, and will be exposed to the danger of distortion. Local ferruginous patches have a deleterious effect even in the burning of an ordinary brick, where probably their harmful effect may be attributed to the introduction of irregularities in expansion that lead to weakness in the furnace.

clearly understood if we consider a substitute that has been proposed for the pure brick. After service, the roof-brick in its outer zones contains an average of 20 per cent. of iron oxide, mainly as magnetite. For practical purposes, therefore, the furnace might be regarded as being built of magnetite bricks, and it has been suggested by several writers that a ferruginous brick might prove a successful substitute for one of pure silica, but whether the improvement in strength would outweigh the loss in resistance to corrosion is rendered doubtful by the following considerations.

The corrosion of the roof takes place through the formation of a viscous slag that runs slowly from the surface of the bricks. An analysis of this slag is as follows:- SiO_2, 65.3; Fe_2O_3, 31.7; Al_2O_3, 1.2; MnO, 0.7; CaO, 0.3 per cent. Now during the corrosion of an ordinary 9-in. brick, the removal of 3 in. of the brick corresponds with a loss in weight of about 3 lbs. of silica. The iron oxide that has combined with this silica to form a slag of the above analysis must, therefore, weigh about 1½ lbs. A further amount of iron, roughly ½ lb., is held in the pores of the brick, especially in the tridymite zone. The total iron oxide discharged upon the brick during the period considered has, therefore, been about 2 lbs., and of this the iron held in the pores forms a considerable proportion. The porosity is, therefore, by no means a negligible factor in the preservation of the brick. Turning again to the fluxed layer, it will be seen that, since the rate of discharge of iron upon the surface is dependent solely upon furnace conditions, the rate of corrosion will depend simply upon the viscosity of the slag—this, again, with a pure brick, depends only on the furnace conditions—and upon the amount of silica in each cub.

Basic Furnace.

Zone.	SiO_2	Fe_2O_3	FeO	Al_2O_3	CaO	MgO	Mn_2O_3
A (cristobalite)	89.00	3.59	0.75	0.80	3.90	0.65	1.11
B (tridymite)	88.80	4.39	0.50	0.70	3.85	0.72	1.00
C (transition)	91.00	2.56	—	1.80	4.20	0.10	0.52
D (unaltered)	97.30	0.48	—	0.70	1.15	trace	0.14

E. Rengade, Anal.*

Talbot Basic Furnace.

Zone.	SiO_2	TiO_2	Al_2O_3	Fe_2O_3	CaO	MgO	Alk., etc.	S.G. powder.	M.-P. Deg. C.
A (cristobalite)	92.20	0.07	0.76	4.57	1.80	0.21	0.39	2.238	1,595
B_1 (tridymite)	89.17	0.19	1.12	5.64	3.00	0.47	0.41	2.393	1,580
B† (transition)	88.20	0.25	1.78	4.07	5.00	0.36	0.34	2.390	1,610
C (transition)	87.85	0.28	1.55	4.07	5.50	0.45	0.30	2.468	1,610
D (unaltered)	95.50	0.10	1.19	0.71	2.00	0.14	0.36	2.451	1,710

* E. Rengade. *Comptes Rendus*, vol. 166, 1918, p. 779.

† Analyses privately communicated by Dr. J. E. Stead for publication in the present memoir. Zone A, P_2O_5=0.167.

In view of the great difference in the degree of corrosion of the gas- and air-ports, it would seem that the oxidising character of the gas-mixture used must play an important part in the preservation of the lining itself. Even if the temperature were not raised, a mixture rich in gas would be likely to "burn down" the brickwork at an increased rate.

Physical Constants in Relation to Practice.—The widespread use of silica-refractories has been determined mainly by two distinctive properties. On the one hand melts derived from silica are exceptionally viscous and afford a thick protective fluid layer; on the other hand the melting-point curve is remarkably flat and consequently at high temperatures a large proportion of silica remains in the solid state even in the presence of much impurity. Another important property is the high reflecting power of melted silica, which only permits a certain proportion of the incident radiation to penetrate the surface; the heat is "thrown off" and thus the heat loss through the brickwork is diminished while the intensity of radiation in the furnace is maintained. Reference has already been made to the fluid layer; the viscosity of this layer is of the utmost importance, and the thinner it is, so much the less durable will be the brick. In this connection mention may be made of a trial of aluminous bricks in which the observed greater corrosion was almost certainly due directly to the thinning action of the alumina. Concerning the heat-capacity and conductivity of the brick, these properties increase with the density, bricks for insulating purposes being made as light as possible. For the steel furnace, however, the advantages to be gained from efficient cooling seem to outweigh any heat economy that might be obtained by the use of light bricks. Moreover, the weight of the brick is determined by other more important considerations that will be given below.

Porosity and Density.—The demands made upon the silica-brick in a furnace-lining will perhaps be more

in. of the brick. Under the same conditions, the denser the brick, the greater will be the amount of slag that it can form, and the longer the period of service before the first 3 in. have been fluxed away.

In a brick identical in structure with the black zone of the roof-brick the added magnetite would occupy the pores of the brick, and so would not diminish the silica-content; nevertheless, the removal of this iron would necessitate the formation either of more slag, for which no silica is available, or of a thinner slag, accompanied by more rapid corrosion. In the case of a magnetite-brick made by the ordinary process, the porosity would be higher and the magnetite would occupy the place of a part of the silica, so that the silica-content of the brick as a whole would be less, a condition even more undesirable than that of a soaked brick.

For use in the steel furnace, setting aside the question of spalling, the main consideration is the concentration in each brick of the greatest possible weight of silica. Density and porosity are to a great extent mutually exclusive properties, between which a choice must be made, but without doubt a high density is the more important. On this account over-burning, which lowers the density, is undesirable. Quartz has a greater density than other forms of silica, and, provided that the other properties are satisfactory, the best brick is to be expected from the use of as large a proportion as possible of a ganister that does not undergo conversion during burning. This condition is fulfilled to a conspicuous degree in the bricks made from the Sheffield ganister.

In the bricks used for the ports, where the refractory character is most severely tested, the porosity is important, for the whole structure at this point becomes soaked with slag, and the amount of foreign matter brought in depends upon the porosity. The strength of the brickwork is dependent, of course, upon the amount of free silica present at furnace temperatures,

and it is evident that the bricks for this part of the structure will increase, not only in durability but in strength, in proportion as their porosity diminishes.

Spalling.—The minor improvements in physical properties that can be produced in a commercial brick are limited by the necessity for guarding against certain physical defects that arise only too easily when any departure is made from standard methods of preparation. The permanent expansion and strength have already been discussed, but there remains an important defect concerning the causes of which but little is known. When a new furnace is first brought to a red heat, even with all reasonable care, it not infrequently happens that the exposed ends of many of the bricks crack off at a depth of 1 in. or more and fall to the bottom of the furnace. This is termed "spalling." In general terms it may be attributed to the inability of a new brick to withstand the stresses produced by the expansion of the surface-layer, and it would seem that a comparison of the expansions at low temperatures with the strength of the brick should throw light on the cause. It has been suggested that the large expansion of cristobalite near 270 deg. C. is the determining factor, but unfortunately, although but little cristobalite is present in the majority of bricks, the defect is still too frequently met with. This question offers one of the most important subjects for investigation in connection with silica-bricks.

Various laboratory tests have been proposed in place of actual trial in the furnace; they rely generally upon an imitation of furnace conditions, and, while yielding characteristic results, do not throw direct light on the causes of spalling. After being heated to 600 deg. C. most bricks show a marked diminution in crushing strength, and this has been used as a test. Evidently the heating causes numerous cracks within the brick, and it is clear that there is but little margin of strength. A property that seems to have escaped investigation in this connection is the elasticity. The differential heat expansion between two layers is ascertainable from the expansion curve, but the value of the shearing stresses developed will depend on the elasticity. A substance may show a high maximum stress, but if it is deficient in elasticity the danger limit will quickly be reached under unequal thermal expansion.

The practical importance of spalling can hardly be exaggerated. One of the main reasons for the advocacy of an iron-silica brick for the lining is the elimination of spalling, and it must be admitted that the probable reduction in the life of the furnace through the causes previously dealt with might well be more than compensated by the elimination of the even more serious damage that results from spalling, by which some inches may be lost from the surface in a few minutes.

The Grindle Pulverised Fuel Plant.

A recent issue of "The Iron Age" gives some new features of the Grindle System for burning powdered coal. The system of conveying coal from the powdered coal reservoirs to the hoppers serving the burning equipment presents several new features of interest. The powdered coal is elevated to a storage hopper, from which it is passed by gravity to a weighing tank. When the tank is filled the flow of coal from the hopper is stopped by a shut-off cock, controlled by a drop chain connected with a lever. All the connections with the weighing tank are flexible, so that the tank alone rests on the scales. The storage hopper above the tank is separately supported by steel columns. Ordinarily the storage hoppers range from 5 to 30 tons capacity to serve hoppers at the furnaces ranging from ½ to 10 tons capacity. The hopper used at the National Malleable Castings Company plant at Chicago has a capacity of five tons, and serves three melting furnaces with feeding hoppers of eight tons capacity each. It is stated that this storage hopper could serve 10 furnaces of the same size.

The coal is conveyed from the tank to the furnaces by air. The latter is forced by a compressor into an accumulator, shown in the drawing, which provides a constant pressure. From the accumulator the air passes through a separator, to remove moisture, and then into the top of the weighing tank. As an additional safeguard, to prevent clogging of the connection between the tank and the conveying line, air is also connected directly from the accumulator through a second moisture separator to a feeder just below the discharge end of the tank.

The feeder is an enlargement of the coal conveying pipe and contains three connected air jet castings, which force the air received directly from the accumulator on an angle upward into the main conveying duct above. The purpose of the air jets is to break up accumulations of coal which might stop the passage between the tank and the conveying line and to supplement the air pressure in the weighing tank. An air meter located between the first moisture separator and the tank and feeder indicates the consumption of air, which is usually about 200 cu. ft. per ton of coal. Coal, at 10-lb air pressure, is blown from the tanks to the furnace hoppers at the rate of 18 tons per hour. It is to be observed that the powdered coal is conveyed as a solid rather than as a mixture of coal and air.

The coal flows from the furnace storage hopper to feed screws, one serving each burner. The feed worm is cast in a special mould, giving it a gradual taper which tends to loosen up the coal at the discharge end and prevent packing. As a further precaution against packing, a revolving disc is situated at the end of the screw. The coal is delivered by the worm to a mixing chamber, where it is mixed with air for combustion and carried to a so-called carburetter, which may be 3 to 100 ft. from the coal control. The air is supplied by a low-pressure blower direct-connected with a constant speed motor. The mixture conveying-pipe and the burners are of cast iron, with tongue-groove joints encased in cement to prevent leakage.

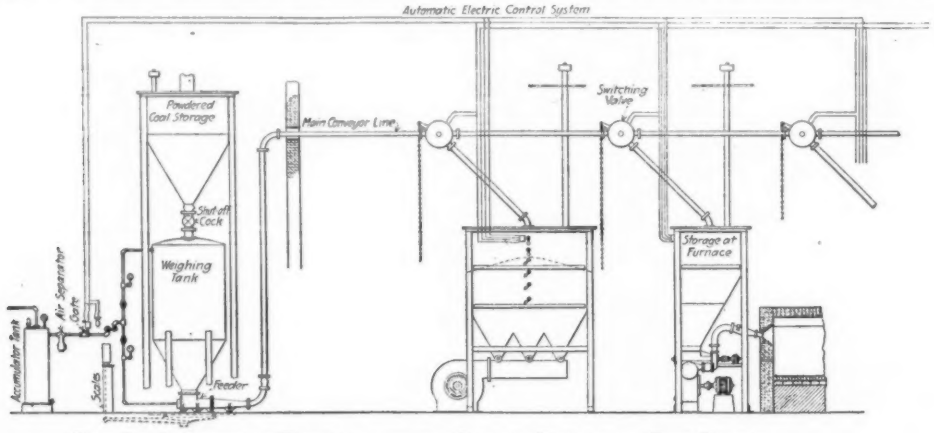

FIG. 1.—A SECTIONAL ELEVATION OF THE GRINDLE PULVERISED FUEL PLANT.

Combustion is controlled by the speed of the coal feed and the volume of the air utilised in the mixture. The air supply is regulated by a specially designed air-gate, which is connected with a control dial graduated to indicate the size of the gate opening. A graduated marker similar to that used to regulate the air valves controls the Reeves transmission, and hence the speed of the screw. Both the marker for the air valve and those for the screw speeds may be set in accordance with the carbon dioxide analysis of the stack or on the basis of previous experience, after which a labourer can operate them successfully and know he is getting the proper mixture of air and powdered coal.

The Grindle system of burning powdered coal has also been installed at the Buffalo plant of the American Radiator Company. When the Grindle equipment was first installed it was expected that the reduction of slag resulting from the decreased oxidation of the metal would be replaced by the ash from the coal, but it was found that the slag was reduced from seven and eight truck loads to three and four, and that no other ash could be found except a small amount which dropped in the bottom of the stack, aggregating about three wheelbarrow loads per week. It was also discovered that the stack temperature was about 200 deg. less than when the furnace was hand-fired.

The Grindle equipment for burning powdered coal, is manufactured by the Combustion Economy Corporation, 1901, South Rockwell Street, Chicago.

The Production of an Oven Roll in Green Sand.*

Perhaps a little explanation is needed as to the meaning of "The Oven Roll." The oven is one used for the purpose of baking biscuits, and is of various sizes and lengths, whilst the roll is one of a number used in connection with a revolving platform which runs continuously through the inside of these ovens. Biscuits on plates are placed on one end of the moving platform, which carries them through the heated chamber, and by the time the biscuits reach the other end, they are sufficiently baked, and are taken off.

When the pattern of this roll came into the foundry it did not seem to present any difficulties. The mould was made in the ordinary way—that is, the moulding process was carried out as the pattern-maker indicated. Although good castings were obtained, it was not until the rolls were in use that some slight defect prevented it giving satisfaction. For the successful working of these ovens it sometimes is necessary to stop and start the rolling platform at certain intervals. It was during one of these intervals that the defect was discovered. The platform, when brought to rest, would sometimes move backward or forward. This movement very naturally upsets the working conditions of the oven and often results in broken biscuits. The reason for this movement was caused by the roll-casting not being evenly balanced; that is to say, one side of the roll was thicker than the other, and, of course, the thick or heavy side would move the platform according to the position of the roll when stopped. To remedy this defect it was considered necessary to entirely alter the moulding. This did, eventually, prove entirely successful.

The First Method of Moulding.—The pattern shown in the left half of Fig. 1 is just a plain solid piece. The right half is a section through the main core. In the top corner is a view of the end core which is used for the purpose of

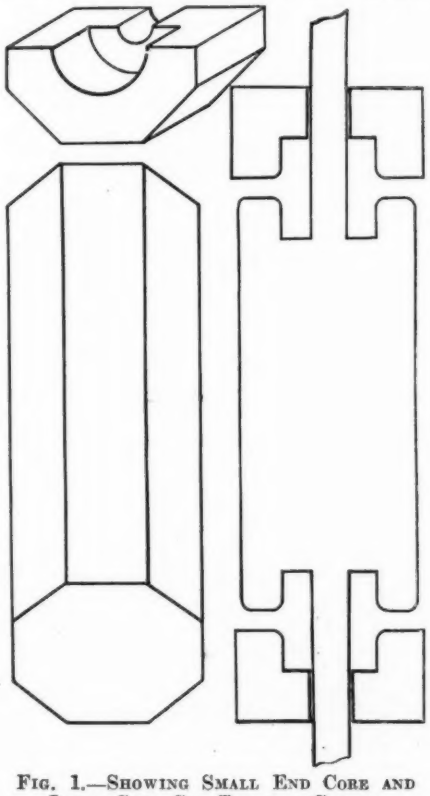

FIG. 1.—SHOWING SMALL END CORE AND LARGE CORE CUT THROUGH CENTRE.

obtaining the external bosses and for forming a bearing for the main core. There are four of these cores, two being placed at each end of the roll. There are also internal bosses, which are formed on the main core. The process of moulding this roll does not call for much explanation. It was made on the horizontal, as this was indicated by the pattern-maker. The pattern was first laid on the top half of the moulding box, which had been rammed up and struck off to form an odd side; the bottom half was then put on, and partly filled with sand and rammed up. The chaplets blocks were then placed in position, the box was then filled with sand, and the ramming completed. After sufficiently venting the moulds, the boxes were turned over and the joint made. The top half was then put on, runner and riser sticks placed in position, the top rammed up and lifted off, and finished. The pattern was then rapped and drawn from the sand, and care was taken in cutting the runners, for sufficient gates must be made to distribute the metal over as wide an area as possible to enable the mould being evenly and quickly filled. Two down gates were used, one on each side of the mould, to enable two ladles to be used. The metal should be hot, so as to get a good grip on the top chaplets. Very often, if dull metal is used, the top chaplets (being the furthest away) become loose, resulting in scaly patches on the top of the casting.

Chaplets.—The chaplets were then placed in position, and great care must be taken during this operation, and proper gauges should be used to ensure that the exact thickness of metal is obtained. The first method used was to have suitable wooden blocks, rammed up in position, in the drag, and secured either under a box bar, or by other means. The distance from the face of the mould, plus the thickness of the metal, down to the blocks was first taken, and the chaplets were then cut to the measurement plus $\frac{1}{8}$ in. They were then sent to the smith and a point was drawn out. The drawing out of the point will lengthen the chaplets by about $\frac{1}{2}$ in., and this will be the length to be driven into the wooden blocks, but before driving in the chaplets each corner of the plate should be turned down to an angle of about 45 deg. This operation is necessary when the metal is thin, to ensure that the plates are held fast in the metal, also to prevent the corners cutting into the core and causing dirt in the mould. The chaplets were then driven into the blocks, two strips of suitable wood were placed on the face of the mould, and a small straight-edge was used. Care must be taken to keep the chaplets upright and drive them flush with the gauges; it will then be found that each chaplet is sufficiently firm, which will allow the core being properly adjusted. The mould is now ready for the core.

Core-Making.—Referring to Fig. 1, it will be noticed that it has only a small outlet at each end, which is only 2 in. in diameter, so that the core will be completely surrounded by metal with the exception of the ends. Care must therefore be taken in their construction, for any strengtheners that are put in will have to pass through this small space; this precludes the use of heavy grids or frames. Further, the air will all have to pass off at these two ends, therefore means must be taken to have a proper and clear passage for its quick escape during casting. The method adopted was to obtain first a small barrel or pipe provided with suitable holes, two of which are tapped to suit a three-eighth lifting iron for the purpose of lifting the core into the mould. This barrel was rather longer than the core for the

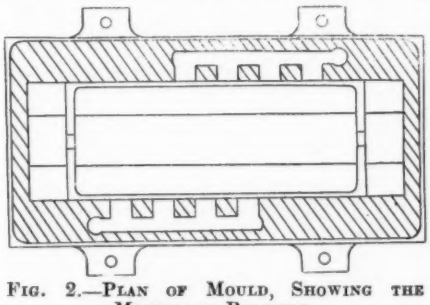

FIG. 2.—PLAN OF MOULD, SHOWING THE METHOD OF RUNNING.

* Paper read before the Coventry Branch of the Institution of British Foundrymen.

purpose of providing an outlet outside the mould. At both ends thick string was spun on to the barrel, and run sufficiently towards the centre (that was considered necessary). These two ends were then struck up in fine loam. Care was taken to make them to the exact size, as they had to form the bearing for the large core. Any slackness of these ends or bearing would very naturally let the core drop lower than was needed. The barrel was then dried, then a few courses of bonding, either hay, straw, or wood, was run on the barrel, but between each coil a rough course of loam was rubbed on. This was necessary to prevent the bonding crushing during casting. A final coat of loam was then run on roughly and dried, presenting a good foundation on which to build the green core. The rough centre was then dropped into the core-box, the position of the top chaplets was measured off, and bearing blocks inserted down to the barrel. These blocks are made of cast iron and are used to prevent the top chaplets from bedding into the core, which would result in its

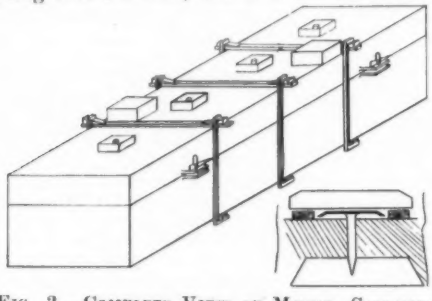

Fig. 3.—Complete View of Mould, Showing Method of Clamping.

rising. Care was taken in ramming up the core, for if the bottom is too soft the bottom plate of the mould will increase in thickness, whereas if the core is too hard it is likely to cause the roll to crack during contraction. A few ¼-in. rods were laid in to strengthen the core, and cast hangers were used to carry the bottom sand. These rods, being straight, can easily be removed, whilst the hangers, being cast iron, can be broken before removal. The top of the core-box being open necessitates the use of a strickle, which often results in undersized cores, for however careful the coremaker may be, it is not so sure a method as when the sand is rammed against a box. The core was then put on a plate ready for the stove.

Fig. 2 shows a plan of the bottom mould with the cores in position and the runners. The two half-cores are placed in the mould at the ends first, then the large core is put in position, and the other small end cores complete the process. The runners have a number of gates along each side of the mould, which cause the metal to pitch up against the large core. This method of running may be a debatable point, as the casting might have been run at each end between the cores, which would have prevented the metal pitching against the large core, but the thickness of metal has to be considered. It is only 5-16ths in.,

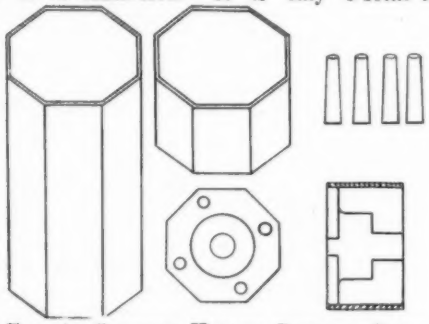

Fig. 4.—Showing Hollow Pattern, Small Internal Core Box, Position of Studs on Bottom Plate of Box and End View of Box and Studs.

which necessitates the mould being filled very quickly in order that the casting may be run at all points.

Fig. 3 gives a complete view of the mould, showing the method of clamping. The three cross-bars are right on the top of the chaplets, and when a consideration of the lift under the core is taken, the necessity of having something safe to prevent the core being shifted from its position will be seen. As there is an upward lift of well over 9 cwt. during the casting process, it is much safer to clamp the mould than to trust to weights.

The Defects.—The defects of the casting, which consisted in unequal thickness of the metal, may be caused in various ways. One cause would be careless strickling on the surface of the core, which would result in a small core and a thick plate on top; secondly, if the bottom of the core was too soft to stand the upward pressure of the metal during casting, this would cause the bottom plate to thicken; thirdly, a fairly general cause is that the mould increases in depth, while the cores decrease, and so throwing the mould out of balance; finally, inequalities may be caused by strains, especially if the mould is on the soft side, but uniformity in thickness is very difficult to obtain when casting a roll of this description on the flat

The Alternative Method of Moulding.—The new method was to cast in vertical position, and as the roll is not of the usual cylindrical form, and the core, having such small supports at the ends, is rendered too weak to be laid in the mould and then to be raised to a vertical position, without

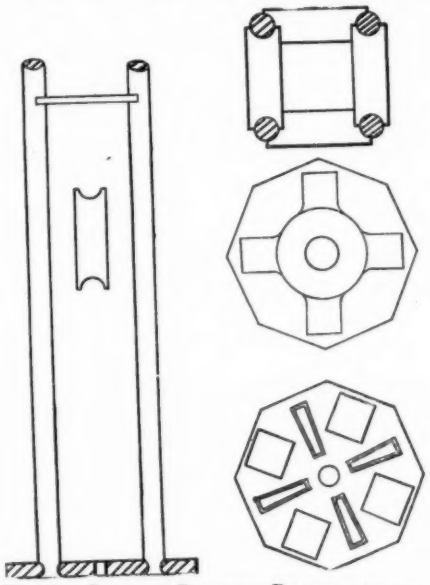

Fig. 5.—Showing Relative Position of the Other Two Cores to the Core-Box.

first having secured it by chaplets or other means. Thus uniformity of thickness would not have been obtained; therefore a special pattern was made with which the roll could be moulded in a vertical position.

Fig. 4 shows the hollow pattern, which is 24 in. in length by 5-16 in. thick, from which was cast a short piece about 4 in. deep. This piece was used as a core-box, and was cast from the pattern for the purpose of getting it slightly smaller by contraction, because the pattern will eventually have to pass over this core when in position for moulding. The plate, boss (which is the bottom of the core-box and will form the internal boss), a sectional view of the box, and some plain studs (the exact length and depth of the core—¾ in. dia., slightly tapered) are also shown in the figure. The studs are rammed up in the core, the position being plainly marked, and are used to take the bolt strain.

Fig. 5 shows the base core-box. A cross has been added to the external bosses, with one end of the cross pointing to one corner of the octagonal; the cross, however, on the top of the roll must point to the reverse corner. This core has also four plain studs rammed up as in the internal core. A view is also given of the two cores, showing their relative position and the method of establishing this.

Fig. 6 shows views of the grid or support for the green-sand core—a small plate ⅝ in. thick and

about 1 in. less in diameter than the core, with four slots and a 1-in. hole in centre. These slots allow the air to escape from the internal core into the green-sand, and also allow the plate to be broken more easily when removing from the roll. The centre hole is to allow the bolt to pass through when securing the plate in position. This

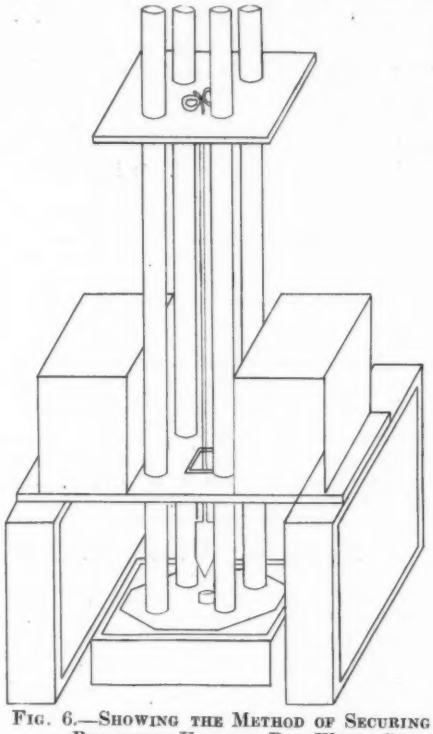

FIG. 6.—SHOWING THE METHOD OF SECURING A PERFECTLY UPRIGHT ROD WHEN CASTING ON PLATE.

plate is cast on to four 1-16-in. round bars 64 in. long. Owing to their length they require a small support at the top to prevent them springing and so cracking the core. Four small pieces of iron, made to fit the bars, are pressed in position and secured by copper wire. These pieces are not put in position until making the core. The plate and boss used in the top of the roll is also shown in the figure.

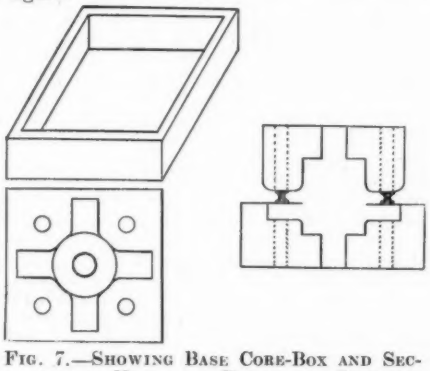

FIG. 7.—SHOWING BASE CORE-BOX AND SECTIONAL VIEW OF BASE AND INTERNAL CORES.

The necessity of adopting some method for vertically securing the rods during casting on the plate is demonstrated in Fig. 7. The plate is moulded in a small box, with four pieces of metal rammed in the mould. It is then carefully levelled and left open, and two boxes of a larger size are then placed one on each side of the mould. These are also levelled, and a small cast plate drilled with four holes, which are an easy fit for the rods and a proper distance from each other. A 1½-in. square hole is provided in the centre. This plate is laid upon the two larger boxes, and a bar is then put through each hole with their ends standing on the mould, and a rather smaller second plate, with four holes similarly placed, is then put over the top of the rods and held in position by cord. Cord is now passed through the small hole in the bottom plate, the bars are carefully adjusted, and weights are put on the bottom plate to steady the bars.

Fig. 8 shows a plan of the bottom base-core in position. The first moulding box, which is 20 in. square by 4 in. deep, is bolted to a cast plate 30 in. × 30 in. × 1 in. This plate is provided with holes for venting. The box and plate are first laid on two wooden blocks across the pit; and two 1½-in. sq. guides are bolted to the lugs on the side of the box. This plate and box are now carefully levelled, using four large hard wooden wedges. A round cast-plate ½ in. thick, slightly larger than the base-core, is now put into the box. This plate, which has a 1-in. hole in the centre and a bevel edge, is used for the levelling of the base-core when placed in box, the bevel edge allowing small wedges being inserted if necessary. The base-core is now put on the box, and, to make sure the straight studs are resting on the round plate, a slight tap with a hammer should be given them, and the core levelled. The proper position for the pattern, which, of course, will have to rest on the core, is determined by replacing the boss and cross into the core provided

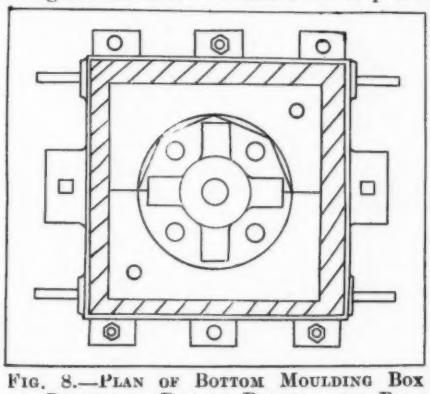

FIG. 8.—PLAN OF BOTTOM MOULDING BOX BOLTED TO BOTTOM PLATE, WITH BASE CORE IN POSITION.

with centre lines. The lines are transferred to the core, which will form the position for the corners of the pattern. A circle is then struck with dividers, using radius from the centre of the boss; this enables the placing of the pattern in position. The boss is now removed and the 2-in. centre-core is placed in; this core has a hole through it sufficiently large to allow the ⅝-in. bolt to pass through easily, but care must be taken to seal up any slackness, or the metal might get worn through with disastrous result. The four small studs are now put exactly on the straight studs in the base-core and the internal core placed in alignment. This core is centred from the circle on the bottom core, and the plate with the rods cast in is now stood upright upon this core. A ⅝-in. bolt, passed through the plate and the 2-in. core, is secured to the bottom plate, but before the bolt is finally tightened the steadying pieces are pressed between the rods at the top and secured. The space between the two cores is packed with cotton waste to prevent sand getting into the boss, and the space between the bottom core and the box is rammed up and a joint made. The pattern is now put over the rods into its proper position, and the next moulding box put on and tightly cottered down. The whole is then lifted off the wooden blocks and lowered into the pit. The venting for the core is a ¾-in. pipe, which is placed over the bolt and is securely tied in the centre of the rods. The two gauges representing the depth of the roll are placed in opposite corners of the box. They are ½-in. round rods, and are used to determine how far the pattern is to be drawn up before the head is put on.

Fig. 9 shows the box and pattern ready for the ramming and also a view of the method of guides used on the box. Care must be used when ramming the mould, for it must be made very firm to withstand the pressure of metal at the bottom, which is about 22.75 lbs. per sq. in., whereas the pressure at the top will only be 3.25 lbs. per sq. in. Care will also have to be taken while the pattern is being drawn up, for it will now have to be supported by the sand which is rammed against

it. It must not be drawn too far each time for fear of ramming the core out or the sides in; again, it must not be allowed to slip back, for this would form a ring round the casting by the bottom edge of the pattern. Before the last box is put on a joint must be made on the outside, as this box will have to be lifted to allow a core

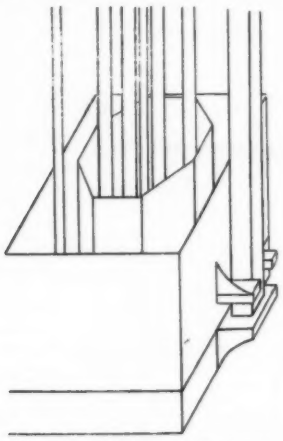

Fig. 9.—View of Pattern and First Moulding Box in Position.

support. Four small iron blocks were found necessary to keep the core firm and to ensure uniformity of thickness. Depth gauges are now placed to form a continuation of those already in position; this allows of the box being parted at the joint. The ramming is now completed to the top of the roll, and the pattern is now flush with the gauges. The vent pipe is now drawn out to allow the internal boss to be bedded in, but care must be taken to avoid filling up the hole; the top plate to form the metal thickness is fitted in, and the external boss and cross set to the reverse corners of the cross at the bottom. The top joint is now made and the top box put on and rammed up, which completes the whole of the ramming.

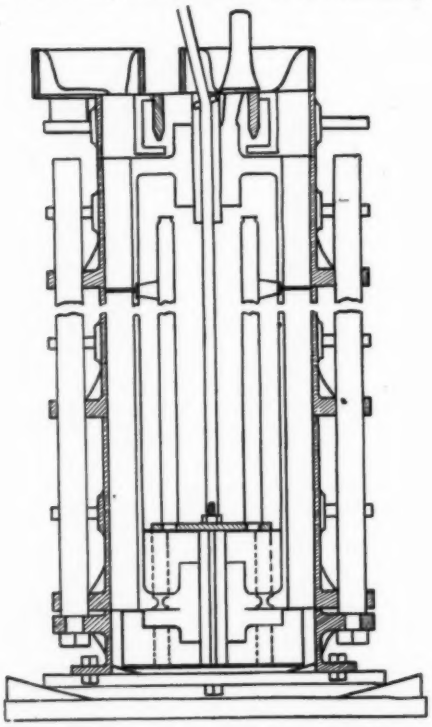

Fig. 10.—Complete View of Upright Mould.

Fig. 10 is a sectional view of the complete mould. It is not necessary to lift the mould very far, provided that the sides have not been rammed in or the core split. Two gates are cut sufficiently large to fill the mould quickly. The sand joining the internal core is sleeked up, and any dirt in the boss is blown out; the mould is carefully closed again, and the top box is now lifted sufficiently high to allow the supports being put in. These are small pipe nails, and rest against the small blocks in the core and packed against the edge of the box. The box is lowered again and the small 2-in. core is put into the top of the large core. Any slackness must be sealed up, as the air from the large core will all have to pass through this small core. The top box is put on and a small pipe is inserted into the vent-hole in the 2-in core. This pipe is provided with a back nut to prevent slipping. The runner and riser boxes are now made up on the top and the mould securely cottered down, after which the mould is ready for the metal. It is cast with one ladle and weighs about 4 cwts.

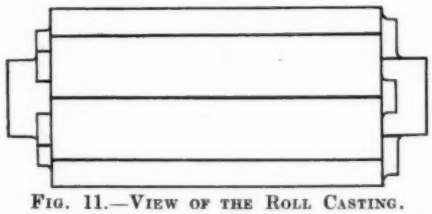

Fig. 11.—View of the Roll Casting.

The roll casting, which proved quite successful and gave perfect satisfaction, is shown in Fig. 11. Its main dimensions are 6 ft. long by 11½ in. between faces.

Refractory Crucibles.*

The making of crucibles from highly refractory oxides has been further investigated recently. It has been found possible to make such crucibles without the use of the clay or binder, which tends to reduce the refractoriness of the finished product. Usually this is effected by preparing a portion of the oxide in a colloidal state by grinding it extremely fine in the presence of soda or other suitable dispersing agent, or even by precipitating it from solution. A recent method is to make crucibles with the use of water by tamping the plastic mass inside a fireclay mould lined with plaster of Paris. When the mould and crucible are fired to a red heat the plaster disintegrates and permits the crucible, which is then fairly strong, to be removed from the mould. The crucible is then fired to a high temperature in order to give it the necessary density and strength.

It is difficult to imagine that this method is likely to be any improvement on the ordinary use of plaster moulds when a plastic paste has to be used. If, on the contrary, the refractory oxide is suspended in water or other fluid, and is cast in a plaster mould, there may be some advantage in the process, though this at least is doubtful, and the destruction of the mould would make the process costly.

Still another method is to mix linseed oil with a refractory oxide and to shape the crucible inside a detachable metal shell, the crucible being then baked in the shell in an oven—a similar process to that employed in the baking of cores for castings. After the baking, the shell is removed and the crucible fired to a high temperature, which results in the burning out of the temporary carbonaceous binder and the sintering of the refractory oxides, thus forming a dense, strong, and highly refractory crucible. This method is less objectionable, and has, in fact, been used to a considerable extent in making special crucibles for certain steel alloys where clay could not be employed.—

DEPARTMENT OF OVERSEAS TRADE.—Samples or catalogues of German and Austrian catalogues of iron castings can be inspected by the Comptroller-General, Department of Overseas Trade (Development and Intelligence), 35, Old Queen Street, London, S.W.1. Their numbers are:—2,826, 2,838, 2,847, 3,424, 4,505, 4,725, 5,310, 7,069, 7,094, 7,625, 7,633, 7,997, 8,024, and 10,900, and for stoves and ovens 4,281. Iron castings coming from other countries 1,573H (Japanese), 1,978A (U.S.A.), 1,990P (Spanish). and 2,170A (U.S.A.).

* "The Chemical Trade Journal."

Institute of British Foundrymen.

NEWCASTLE BRANCH.

At the meeting held on December 11, 1920, a paper was read by Dr. Paterson on "The Welding of Cast Iron." Mr. George Vardy, M.B.E. (Branch President), was in the chair.

The Welding of Cast Iron.

It should be clearly understood that this paper does not aim at giving a full scientific account of the principles involved in welding cast iron, but deals broadly with what is really a somewhat difficult and incompletely investigated subject.

Making a weld in cast-iron by either oxy-acetylene or electric processes involves heating the metal locally to such a temperature that it melts, and, in addition, introducing into the weld a molten metal of a totally different composition to the cast iron being welded. That portion of the original metal adjacent to the weld is heated up for a short period to a high temperature, and it is necessary to understand the changes which take place in grey iron when subjected to high temperatures, before the problems involved in cast-iron welding can be thoroughly appreciated. If grey iron is heated to bright redness and cooled in air, two important changes in structure become evident. In the first place, an absorption of the free carbon or graphite takes place, the extent depending on the time of heating. This absorption results in the conversion of the soft iron into the somewhat hard and brittle one. In the second place the well-defined structure of the iron-iron carbon, eutectic, or pearlite, is replaced by a confused structure of low tensile strength. If a micro-section is taken from a piece of low-carbon steel adjacent to a weld it will show, under low magnification, the gradual change from well-defined to diffused pearlitic structure as the margin of the weld is reached. A similar change occurs in cast-iron, but is not so readily recognised in a microphotograph. Both of these changes cause a considerable deterioration in the mechanical strength of the cast-iron. Attempts are often made (as will be explained later) to modify them by a suitable heat treatment. The metal which is fed into the weld is generally either cast-iron or mild steel. In either case the resultant material is similar to the original metal in having a high-carbon content, the cast iron containing it originally, and the molten steel absorbing it readily from the surrounding metal. Whatever the welding process, this added metal cools very rapidly, and unless precautions are taken, a hard and brittle metal results. If a portion of an electric weld made on cold iron with a cast-iron rod as filler is microscopically examined it will be seen that the structure is in every way similar to that of a piece of chilled grey iron. Such a weld will, of course, be extremely hard and brittle, and cannot be machined, but must be ground to shape with an emery wheel. As it is necessary that many welds should be machined to shape after having been completed, the methods adopted to produce soft and machineable weld metal are important. What is still more important is that a soft weld has better mechanical properties than a hard one. One method, the oldest, consisted in using a metal as filler in which carbon was not readily soluble; brazing brass being the most usual. A brazed joint properly made is perfectly satisfactory, but can only be used when very small proportions of filling metal are required, as in the case of small cracks and flaws. Considerable personal skill is required to keep the joint full of spelter during the operation. Another method consists in removing the carbon from the edges of the weld by means of an oxidising agent before commencing operations. In one patented process of this kind a mixture of manganese peroxide, copper oxide and borax was kept fused for some little time on the face of the surface to be welded with an oxy-acetylene blow-pipe, and then, after removing the mixture, filling in the weld with mild steel. As it is impossible to remove much carbon from the edge of a piece of cast iron without prolonged heating, it is not likely that such a method would be successful. Modern practice endeavours to produce a soft weld by reducing the carbon content of the weld metal as much as possible during welding, and then applying a heat-treatment which modifies the hard metal produced by rapid cooling.

The reduction of the carbon content of the metal can be effected in two ways, the first of which is only applicable to oxy-acetylene and carbon arc-welding, and the second of which is applicable to all the three principal methods, viz., oxy-acetylene, carbon-arc and iron-arc welding. The first method consists in melting the filling metal into the weld with an oxidising flame in the case of oxy-acetylene welding, or in keeping it molten long enough to allow the air to act as an oxidiser in the case of carbon arc-welding. The outer edge of an acetylene blow-pipe flame is strongly oxidising, although it contains no free oxygen. Its use is a necessity in cast-iron welding, although most operators do not realise this, but use the outer edge of the flame to prevent the violent blowing about of the very fluid iron which would occur if the inner cone of the flame were used for heating, as is the usual practice in steel welding. The decarbonisation is helped in deep welds by stirring the pool of molten metal with the filling rod, and the action of the air is prevented from causing too violent oxidation, and hence boiling, by means of a coating of flux, generally mixtures containing borax, boracic acid, carbonate and bicarbonate of soda. The use of a flux is not essential to cast-iron welding, and its composition should be such that its function is strictly limited to the formation of a protecting coat on the molten metal.

In carbon-arc welding the use of a flux is essential if good results are to be obtained, and great personal skill is required from the welder, as the temperatures are very difficult to regulate.

In iron-arc welding the use of a flux is impossible, and hence the carbon-arc method is the only one available.

In this method the presence of excessive carbon in the weld is prevented by the use of an iron alloy which does not dissolve carbon freely. The most common one in use is a silicon iron alloy, or a cast-iron rod rich in silicon. Ironfounders are familiar with the fact that an increase in the silicon content of cast iron reduces the amount of combined carbon present, provided the cooling of the metal is sufficiently slow enough, and to a certain extent this holds good for weld metal. In addition to this, silicon-iron is rather more fluid than pure iron, and if it becomes oxidised does not tend to boil on solidification. The practice has certain dangers, however, as an iron containing too much silicon can be just as hard and brittle as a highly carbonised iron, and, moreover, this fault cannot be corrected by any heat treatment.

Those familiar with malleable iron practice are aware of the fact that by suitable heat treatment hard white iron can be made to give up a proportion of its combined carbon, as "temper carbon," and thus become softened. In the same way heat-treatment will soften a weld made hard by the presence of too much combined carbon, and it becomes evident, therefore, that suitable heating of the weld is a very important factor in successful welding, and is a process which should be invariably adopted when the casting is of suitable dimensions.

Heat treatment of a welded casting has a threefold advantage: (1) It softens the weld; (2) it corrects the reduction of strength, to a certain extent, of those areas disturbed by the welding; (3) it enables the strains induced by the cooling, and hence shrinking weld-metal, to distribute themselves in the least harmful manner.

In practice, castings are usually heated in a furnace so designed that the portion to be welded can be examined without uncovering any more of the casting than is necessary. These furnaces are usually gas fired, as this enables an accurate control of the temperature to be obtained and permits the fuel being reduced to a sufficient extent when welding is actually commenced. In such a furnace the casting is slowly heated up to the required temperature and is then welded, being kept as near as possible at the same temperature during this operation. It is then heated for a further

period, depending on the thickness of the metal, and is allowed to cool slowly in the furnace. The temperature actually used should vary with the composition of the metal in order to get the best results, but in actual practice is generally from 800 deg. to 850 deg. Centigrade. It is assumed that the practice of oxy-acetylene welding is familiar to every one, and no attempt will be made here to describe the methods in general use.

As, however, electric welding methods are less generally understood, a short description is appended of the principles and practice of what is known as iron-arc welding.

In this process an arc is struck between an iron rod, or electrode, and the work to be welded. This arc, which is similar in appearance to that of an ordinary carbon arc-lamp, melts the surface of the work and at the same time melts the electrode, which, falling on to an already molten surface, solidifies and forms a permanent joint. The area heated during this process is extremely small, and the molten metal produced solidifies almost at once. The result is that the "puddling" process used by the oxy-acetylene welder is quite impossible in the case of the iron arc welder. Only a mere trace of carbon is burnt out of the metal which is being welded, and the mild steel electrode generally used takes up varying amounts of carbon from the original metal. Cast-iron electrodes or filling rods cannot be used in this process, as the arc splutters so badly that a weld cannot be made. As previously explained, iron alloys are commonly used, which prevent the absorption of too much carbon into the weld. The finish of a job produced by this method is rough, and requires machining or grinding to produce a proper surface.

Carbon arc welding is largely used in the repair of steel castings, but very rarely in the case of cast iron. The process consists in striking an arc between a carbon electrode and the work, and feeding in the extra metal required from a filling rod as in the acetylene process.

Broadly speaking, the sphere of usefulness of each of the two main processes is as follows:—

Castings which must be machined can be welded by either process if the necessary pre-heating is done. Oxy-acetylene welding is preferable for welding cracks, flaws and filling up scores in cylinder bores. Iron arc welding is preferable for building up work, such as the renewal of teeth on gear wheels. When pre-heating is unnecessary or impossible, the iron-arc process is the only one of any value. The heating up of the casting during welding is so much more localised in this process that the contraction stresses are negligible as compared with those set up in the carbon-arc or acetylene process.

Discussion.

THE PRESIDENT said they had had a most interesting address from Dr. Paterson, to whom they were all very much indebted.

MR. W. J. PAULIN said burning-on was still frequently carried out, and gave a machinable job. He then asked if results were improved by reducing the flow of acetylene gas and arranging the mixture so as to produce a more oxidising flame. The speaker gave as an example of successful brazing a table of a hydraulic press which had been successfully used ever since. Pre-heating was necessary in order to reduce all tendency to local stresses. With regard to the question of flux, he was of opinion that one containing about 10 per cent. of boracic acid behaved better than borax.

Another speaker asked if it were possible to make a successful job by welding aluminium electrically.

MR. J. D. CARMICHAEL said he had seen a condenser smashed through shipwreck in different places successfully electrically welded. A piece broken from the bedplate of the same engine was replaced by a piece of malleable iron from the blacksmith's shop by welding it to the original cast-iron. The pumps were similarly treated, and the engines worked as if brand new. Now that welding was successful for propeller blades, it should be applicable for most jobs, for he was not aware of anything, not even a punching machine, that had to stand greater stress, as the whole power of the engine was transferred through the blades.

Another speaker asked for information with regard to the broken flanges and cylinders of engines of German ships which were successfully welded on by the Americans using the oxy-acetylene process.

THE PRESIDENT said he was always sceptical of the welding of cast-iron except where the metal was properly heat-treated. He gave instances of welding where the weld was invisible. He thought the chief factor in a successful weld was the skill of the workman, but some of the best welds had been made by female labour. There must be a certain natural, artistic touch required, as he had experienced cases where men had failed, but where young boys and girls had been successful. The high cost of welding seemed to be based upon 90 per cent. of the cost of the original article; and, if so, it was a case of what they charged and not what the work actually cost.

DR. PATERSON, replying to the discussion, said he had seen some very bad castings on which pieces had been burned-on, and remarked that it was possible to produce more serious flaws in burning-on than were possible in either acetylene or electric welding. Satisfactory brazed joints could be made, but in a large majority of cases they had not the necessary strength. With regard to aluminium welding as long as it was pure aluminium electric welding was quite successful, but when it was other than pure aluminium it could not be carried out successfully. With regard to the repairs done to the engines in the German ships by the Americans, the practice they adopted was more or less new. They put steel studs down the sides of the cracks or breaks, and locked them together by welding over the surface. That was because they were not sufficiently conversant with electric welding of cast-iron to accomplish it by other means, and after a long experience of war conditions, he could say that the Americans were a long way behind us in electric welding. The cost of doing those jobs was three or four times the cost of the cylinders, and their method was only adopted because it eliminated the making of new patterns for the castings, which had not been made in America, and additionally taking the engines out of the ships and rebuilding them. With regard to the President's remarks on the cost of welding, he did not agree that the basis was 90 per cent. of the cost of the original article, but there was no getting away from the fact that it was an expensive process on account of wages. They had to pay high wages for skilled men, and the process was a slow one. No welder could stand the strain for eight hours a day, and they had to charge for what was really a costly job, and the man who invented a speeding-up of electric or acetylene welding—the former was the quicker for thick jobs—would revolutionise the work.

DISCUSSION ON MECHANICAL TESTS FOR CAST-IRON.*

THE BRANCH-PRESIDENT, in opening the discussion, said that he thought they had had a very fine lecture. With regard to specifications, Mr. Cook held out great hopes, and he took it from his remarks that he was on the Engineering Standards Committee, but he himself considered that in the near future all material would be specified, but that need not occasion undue alarm, as the work of the British Engineering Standards Committee must of necessity be slow and sure. Mr. Cook had given the impression that if definite specifications were prepared the position would be improved. As an inspector, his own opinion was that if a foundryman was asked to work to a specification he would be content if the completed job was "near enough."

MR. DOBSON, after expressing his appreciation of the lecture, asked if the saturation scale to which reference had been made, was based on any constant proportion of phosphorus and manganese, and, further, whether the behaviour of the carbon in the author's experience was different in cold blast iron and charcoal smelted iron of similar carbon content? Some people on the Continent were endeavouring to standardise mixtures solely by analysis, and he had noticed that the French Foundry Syndicate last year, in its annual publica-

*See pages 132 and 149.

tion, has given definite analyses for definite types of castings, but had ignored the raw materials, apart from malleable. Had the author any definite experience as to the difference after re-melting of hot and cold blast iron, or did he consider that the condition of the carbon in cold blast iron was changed by re-melting?

MR. COOK, referring to the Branch-President's experience—that the foundryman could not work to definite specifications—he maintained that there were many who could. Mr. Dobson had brought up the question of the relative proportion of total carbon and silicon, and asked whether that was affected by a difference in the proportion of phosphorus and manganese. That had been dealt with in the paper, and the figures he had given showed that they were not affected. Up to 1 per cent. phosphorus, if they had the correct ratio of silicon and carbon, there was no appreciable effect. With regard to manganese, there was no appreciable effect up to 0.7 per cent. Referring to the difference between cold blast and charcoal iron, the lecturer said he had no information with regard to the latter, but the difference between cold blast and hot blast iron was pretty well known to every foundryman. With the same chemical analysis, or with what may be considered as a worse chemical analysis, very much better physical results could be obtained with cold blast than with hot blast iron. The difference was largely due, he believed, to the temperature at which the metal was produced in the blast furnace, and similarly to the question of the casting temperature, once the differences were produced they were maintained throughout subsequent working. This is demonstrated when annealing bars, which still retain the same relative difference as when originally cast, and a metal which had been made at a high temperature in a big furnace did not recover its properties by subsequent treatment, and that was one of the reasons why he thought American irons were inferior to the English.

MR. CLEAVER asked whether there was any specific limit in respect to the combining of silicon with manganese. He had recently dealt with a proposition of cylinder iron with 2.75 per cent. silicon, 1.2 manganese, and 0.9 phosphorus. This seemed to him entirely away from the accepted rule of low to 1.5 per cent. silicon, of manganese about 0.6 per cent., and phosphorus about 1 per cent., but he understood that it had turned out quite successfully for cylinders of 1½ in. section and 6 to 8 ft. long.

In answer to Mr. Cook, he said that they were printing rollers, and not steam cylinders.

MR. COOK pointed out that a callender cylinder was different from a steam cylinder. This metal would give a close grain, which was one of the things desired in callender cylinders. To get this close grain high manganese was helpful. On the other hand, the analysis stated is not satisfactory for steam cylinders, which have to be subjected to superheated steam, or for Diesel engines. High manganese content causes large crystals to be formed, which break off under high temperature working conditions, which undoubtedly induces excessive wear.

MR. CLEAVER said he would like to know whether the author considered that the high-silicon cylinder iron previously mentioned had more fluidity than the ordinarily accepted silicon iron, and whether that would tend to produce cleaner castings.

MR. COOK, replying in the affirmative, stated he had opened by saying that for callender cylinders it gave good results, as regards grain, and that was not only obtained by chemical elements but also by the fluidity of the iron. The action of silicon was perhaps better explained by the question of time. The higher the silicon, up to, say, 4 per cent., the lower the rate of cooling, *i.e.*, the iron could be cast at a lower temperature. In the case of white iron, the time during which it could be successfully cast was short. Callender rollers were cast vertically, and the rate of running was not very fast. The metal came up slowly from the bottom, as it could not be run very fast owing to its thickness; the additional silicon would give greater length of successful pour time, and the temperature would therefore not drop below the critical point before the mould was filled. They had to watch that, because, if they were filling a mould, there was the question of the casting temperature, not only the temperature at which the metal was being put in, but the final temperature at which the mould was completely filled. Although 2.75 silicon was higher than could be desired, he saw as much as 1.2 per cent. manganese, which would assist in getting the desired closeness of grain.

MR. A. WILLIS (Hon. Secretary), referring to the fact that so few were desirous of discussing the paper, said he supposed the reason was that Mr. Cook's lecture was so complete, so detailed, and so much beyond criticism that they were not able to find any opposition or cross-questions on the matter, or very few. Some specifications for castings he considered simply ridiculous and not at all necessary, especially when taking into consideration the purposes for which the metals were to be used: some of them were very expensive, and involved much waste of time and money. Mr. Cook had remarked that the test-bar question for cast-iron in this country was in a state of chaos, and he (Mr. Willis) insisted that these conditions also obtain in the non-ferrous industry. The manner of preparing and passing test-bars was, in many cases, scarcely a gauge of the quality of the metal in the casting; furthermore, the casting conditions of the test-piece were totally unlike those of the casting itself, and he thought the whole subject should be overhauled. Perhaps, now that research associations existed for both cast-iron and non-ferrous metals, better specifications might be forthcoming. Meanwhile, he thought the old-fashioned specifications would stand, as specifications of ten years ago were practically the same to-day, with the exception of the war modifications. He was of opinion that the time had now arrived when a system of specifications which would more accurately represent the value of the metal in the casting should be evolved and put into operation by some authoritative body.

MR. COOK agreed that the methods of testing non-ferrous metals were probably as bad as those used for ferrous metals. A consideration of the difference in the amount of time, trouble, and ingenuity spent in preparing a test-bar from, say, manganese bronze, as compared with that spent in making the casting would justify this assertion. Efforts were being made by the Standards Committee to remedy the present position, but he could not say when the results of their investigations would be published.

MR. A. R. BARTLETT, in proposing a vote of thanks to the lecturer, said at the works with which the speaker is associated they were in a position to carry out practically the same tests as had been mentioned by the author, and it appeared that they were both working on more or less the same lines. One thing the author had not mentioned which might be of use to the average founder, who had not the opportunity of handling any of these scientific tests, was a method of quickly ascertaining the merits of their practice by continually examining the fracture of a standard chill casting of every mixture of metal.

MR. W. LAMBERT, in seconding the vote of thanks, said that he had had the opportunity during the last four months of visiting some 20 or 25 iron foundries, and he wondered whether the lack of discussion on the paper was due to the fact that the iron founder had not the advantage of the testing machines. He had inquired at the foundries he had visited as to the nature of their testing laboratories, and practically all had had to admit that they had no apparatus. Steel foundries were much better equipped in this respect, and he thought it was lamentable that so many iron foundries were so ill-equipped. He had seen some very fine castings, and the fractures apparently were quite good. He had enjoyed the lecture, and it was a pleasure to hear that there were at least some iron foundries that were well equipped.

The vote of thanks was passed with acclamation.

MR. COOK, in reply expressed his thanks, and agreed with Mr. Bartlett's remarks. There were many comparative tests which could be carried out in a simple way, but it should be borne in mind that the same tests should be reproduced in the same way every day, the results tabulated carefully, and variations observed in the results considered. It was surprising what a lot of information could be obtained in this way after working

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for 12 or 18 months. Referring to Mr. Lambert's remarks, the question of the apparatus depended on what work was being carried out. If making sash bars, no apparatus was necessary, but high-class castings which admitted of no variations, such as for Diesel engine or steam engine work, which had to stand high degrees of superheat, it was impossible to go too far into the question of the apparatus employed. A great deal of the apparatus necessary was quite inexpensive, and by its use a very great saving could be effected.

BIRMINGHAM BRANCH.

Annual Dinner.

The annual dinner of the Birmingham Branch of the Institution of British Foundrymen was held at the White Horse Hotel on Saturday evening, January 15, the President of the Branch in the chair. There was a large attendance.

The toast of "The King" was honoured on the proposition of the PRESIDENT.

MR. FRANK SOMERS, President, Staffordshire Iron and Steel Institute, proposing "The Institution of British Foundrymen," congratulated the members on the rapid growth of the Institution. It began in 1904 and numbered over 1,000 members in its nine branches, the highest numbers being connected with Scotland and Coventry. It was surprising how wide a variety of trades were dependent upon foundries. The foundry trade was fortunate in having an accumulation of orders from the moulders' strike, which was still keeping many of them busy. Mutual service was essential to general prosperity, and the increased production which was demanded as the first essential to prosperity was worse than useless, unless there was a reduction in price. They must work harder and practise economy. The foundries must be equipped with efficient plant, because they could not have economy without efficiency. He believed the slump would get worse, but it would be overcome. A great opportunity had been lost in the motor industry through the inability to supply the big recent demand. Now America had come in to fill the gap, and Englishmen were spending money on American cars. No doubt the measures taken by the Government during the war were necessary to prevent extravagance. But he was strongly against continued coal control. It was said prices would go up, but he was convinced a lot of the high prices now paid were due to artificial causes. France might well criticise our friendliness when we charged her £5 10s. per ton for coal. The colliery proprietor had his profit guaranteed, and no doubt the foundry trade would like a similar guarantee which would be highly convenient to himself in the forging trade. Coal would have to be cheaper, because all the users could not be subsidised. It would be necessary to help foreign countries to adjust the rates of exchange. When in America a short time ago he (the speaker) met Mr. A. O. Backert, the American President of the foundrymen, who specialises on economic questions, and he expressed himself strongly in favour of co-operation between the two countries.

MR. WINTERTON mentioned that Mr. Matthew Riddell, the President of the Institution, was unable to attend owing to the sudden death of his father.

MR. H. L. REASON, Vice-President, responding to the toast, said they would all sympathise with the President in his bereavement. He felt a bit hurt when Birmingham had to yield the premier position in membership to Scotland and Coventry. They in Birmingham meant to strive for the first place once more. He was glad to announce that an exchange of papers had been arranged between the British and American Foundrymen's Associations, and Mr. F. J. Cook had been authorised to contribute a paper to America. He greatly appreciated those social gatherings, particularly as the ordinary meetings were all more or less strenuous. The enthusiasm of the leading members was shown by the long distances they travelled to the meetings. A new rule had been adopted which would enable firms to become subscribers, and he hoped numerous firms would now take advantage of that. He did not accept the suggestion that there would be unwillingness on the part of members to join if firms subscribed. He considered ironfounders and kindred businesses were in duty bound to support them, and thereby increase the strength of the Institution. The advantages of such assistance would more than compensate the firms. He was very glad to hear of the success of the Cast-Iron Research Association, and they were proud to know that two Vice-Presidents of that body, Mr. Riddell and Mr. F. J. Cook, were leading foundrymen. The Association would collect most valuable data, and the Government were providing half the cost. The Royal Charter would place the Institution of British Foundrymen on an equal footing with other great scientific bodies. He desired to pay a tribute to the very valuable services rendered by the Branch-President, Mr. Holberry.

MR. W. A. JEBOULT, President of the Birmingham Association of Mechanical Engineers, proposed the toast of the "Birmingham Branch." He mentioned that the Cast-Iron Research Association originated with the Institution of British Foundrymen.

THE BRANCH-PRESIDENT, responding, strongly supported the appeal to employers to take a keener and more practical interest in the Institution, from which they all derived benefit. Foremen, foundry managers, and moulders were proud to be connected with the Institution, and the firms were certainly called upon to give more assistance than in the past. The President expressed his acknowledgments to all the officials who had aided in the success of the function.

PROF. TURNER, proposing the toast of "Kindred Societies," remarked that while there were many societies in the district now devoted to metallurgy, not many years ago there were none whatever in existence. The changes not only indicated the progress of knowledge, but showed that they recognised their mutual dependence. The speaker showed how important societies originating in Birmingham had either migrated to London or led to the formation of national societies.

MR. A. SPITTLE, President of the Birmingham Metallurgical Society, in responding to the toast, said it had been suggested that the various societies interested in metallurgy should be grouped into two or three large societies. Personally, he did not agree with that movement, and he did not think it would be in the best interests either for mechanical or metallurgical science to lump them together. One proposal was that the Staffordshire Iron and Steel Institute and the Institution of British Foundrymen should amalgamate into one society. He thought that would be quite wrong, because the present age was an age of specialisation, and one effect would be that it would be impossible for the foundrymen to introduce papers specially interesting to themselves. The success of the Institution of British Foundrymen was the best argument in support of specialisation. He contended also that the success of the Mechanical Engineers, which was founded on the initiative of Geoge Stevenson, as distinct from the Civil Engineers, was a similar argument in favour of societies devoted to their own special interests.

Refractory Materials for Furnace Linings.

At the Columbus, O., meeting of the Electric Furnace Association, C. W. Berry stated zirconia is one of the latest materials to be offered as a refractory material. It has a high fusion point, and shows resistance to slags of certain types and gives promise of being a valuable refractory. Another type of basic refractory is a spinel of magnesia and alumina. These bricks were tested in an electric furnace bottom below charging door in comparison with magnesite and bauxite brick, and lasted more than twice as long. Sillimanite is a material that has been produced from fireclay by removing part of the silica, and promises to make a highly refractory product. Sillimanite shows considerable resistance to slag penetration and holds up well.

THE copper trade in South Wales has shown a considerable improvement of late, a fact which will affect the employers' demand for a reduction of wages.

Trade Talk.

IT is understood that it will not be long before steps are taken to form a Swansea University Association of Engineering Students of the South Wales Institute of Engineers.

THE annual general meeting of the Institute of Metals will be held in London at the Institution of Mechanical Engineers on March 9 and 10, when six Papers are on the programme. The annual dinner is fixed for March 9.

A PROTEST is to be presented to the Portuguese Senate Commercial Committee against the extension of the concession granted to foreigners for the exclusive iron industry, as a native firm wishes to start in the same immediately.

AT a special conference of the Society of Consulting Engineers and Ship Surveyors, Sir Fortescue Flannery, M.P., presiding, a discussion took place on the question of the new by-laws of the society, certain revisions being made.

MESSRS. HADFIELDS, LIMITED, are in future to bear the cost of the cot called "Hadfields, Limited. managers' and foremen's fraternity cot," at Sheffield Royal Hospital, to which the Fraternity has been paying £52 10s. per annum

EMPLOYERS in the Walsall malleable castings trade. affecting between 1,500 and 1,600 men, have asked for a reduction of 7½ per cent. in gross wages. Men over 20 are asked to accept 40s., compared with the present earnings of 49s. 6d.

A MEETING of the members of the Newcastle and District Association of Foremen Engineers and Draughtsmen was held on the 5th inst., when Mr. Vernon J. N. Williams read a Paper on "A Century's Development of Small Tools."

THE price bureau of the German electro-technical industry has reduced the prices of all electrical machines by 10 per cent. This is the third price cut since maximum prices were reached last year. Prices are now 30 per cent. lower than then.

REGARDED as one of the largest bridges in the world, and one of the engineering marvels of the country, the bridge over Deep Creek on the Pacific Great Eastern Railway, British Columbia, 1,200 ft. in length and 239 feet high, has reached completion.

THE GREENOCK DOCKYARD COMPANY have launched the oil-tank steamer "Orowati" of 7,000 tons gross, which they have built for the New Zealand Shipping Company, London. The vessel will have engines by Messrs. J. G. Kincaid & Company, Greenock.

A CONFERENCE of the Federation of Shipbuilding and Engineering Unions in London have decided to ask the Minister of Labour to set up a public Court of Inquiry into the financial position and prospects of the industry in relation to the wages demand.

AN interesting meeting was recently held at the Engineers' Institute, Park Place, Cardiff, when the members met to discuss Mr. H. J. Allcock's Paper on "Some Commercial Aspects of Engineering," under the chairmanship of Professor David, B.Sc., A.M.I.C.E.

THE Ansaldo Steel Company have substituted an electric process in place of coal furnaces in their works, says an Exchange message from Genoa. This and the employment of oil in place of coal in some other departments has resulted in the discharge of some 200 men.

MESSRS. RICHARD MUNRO & COMPANY, Kelvin Dock Shipbuilding Yard, Maryhill, Glasgow, recently launched a vessel built to the order of Messrs. J. R. Dickson, Jun. & Company. The boat, which is 66 ft. long, 18 ft. broad, 9 ft. 6 in deep, is the first launched at Maryhill for ten years.

MESSRS. PALMERS SHIPBUILDING AND IRON COMPANY, LIMITED, have offered to present to the Imperial War Museum a model of a monitor constructed by them—H.M.S. "Marshall Soult." This monitor carried two 15-in. guns, and was used for operations on the Belgian coast during the war.

MR. REAY, of Stockton, speaking at the annual meeting of the Iron and Steel Trade Conciliation Board in Newcastle, said orders were being cancelled, and practically no new work was coming forward. Unless they could reduce materially the cost of production he was afraid the prospects were anything but bright.

OWING to the world-wide change in the financial and industrial outlook, which has made the prospects for the immediate future extremely uncertain, the Electrolytic Zinc Company has decided to shut down its 10-ton a day plant, but construction work on the plant, which is to produce 100 tons of spelter a day, will be continued.

AT a special meeting of the Chamber of Commerce, Cairns, Queensland, consideration was given to the question of saving the mines in the Cairns hinterland as a national asset. Rare metals, such as wolfram and molybdenite, exist in the Cairns back country, and these were exploited for material supplied to Britain during the war period.

A MEETING of the North-East Coast Institution of Engineers and Shipbuilders will be held on February 18 in the Lecture Theatre of the Literary and Philosophical Society, Westgate Road, Newcastle-on-Tyne, when a Paper will be read "On the Losses in Convergent Nozzles," by Prof. A. L. Mellanby and Mr. Wm. Kerr.

THE GOOLE SHIPBUILDING & REPAIRING COMPANY, LIMITED, have been successful in procuring two large repair jobs in keen competition with Continental firms and North-East Coast firms. The steamer "Fairfield," after being in collision and sunk in the Thames, has been safely brought to Goole, and is now undergoing repairs in dry dock.

LAST week there was launched from the Neptune Works, Newcastle, of Swan, Hunter & Wigham Richardson, Limited, a fine screw-steamer which they are building to the order of the Cork Steamship Company, Limited. The vessel is 290 ft. in length by 42½ ft. beam, and is designed to carry over 3,100 tons d.w. on a light draught of water.

THROUGH the courtesy of Mr. Frederick Jones, M.I.Mech.E., members of the Cardiff Technical College Economic Society recently visited the Junction Dry Dock and Engineering Works, Cardiff, when they were conducted through the dry dock, pumping station, and various workshops, and were afforded a lucid explanation of the ship repairing processes.

GREAT activity is reported from the German shipbuilding yards, and expert opinion in this country agrees that Germany can turn out ships at 25 per cent. to 30 per cent. under our prices and still leave a good profit to the builders, while there is no doubt that Germany, on account of the excellence of her work, will always be a strong competitor of this country.

AN Order in Council published in the "London Gazette" revokes Defence of the Realm Regulation No. 39 C.C., which prohibited the purchase of any ship without the written permission of the Shipping Controller. For some time the Controller's sanction has been freely granted so far as the buying of British ships is concerned, though it remained formally necessary.

THE use of a small proportion of copper in all iron and steel products exposed to air and moisture is advised by Mr. D. M. Buck, metallurgical engineer of the American Sheet and Tin Plate Company. The use of 0.15 to 0.25 per cent. in normal open-hearth or Bessemer steel greatly lessens corrosion, but heretofore the use of copper steel has been chiefly confined to sheet metal. It is estimated that the life of the sheet metal is at least doubled by the addition.

WITH regard to the projected new dry dock at Swansea, which is proposed to be the largest and finest in the Bristol Channel, we understand that preliminary prospecting for a site is being done for the firm acting on behalf of the Anglo-Persian Oil Company. It is stated that the larger oil tank vessels of the Anglo-Persian cannot be accommodated with repairs in the port at present.

THE foremen and officials of Messrs. Pease & Partners, Limited, held a successful smoking concert at the Wellington Hotel Middlesbrough, the other evening, under the presidency of Mr. D. G. Pennington, foundry manager, when Mr Archer, Normandy Ironworks, in an appropriate speech, presented to Mr. E. E. Cockerell, late consulting engineer, with a gold watch, together with gifts for Mrs. and Miss Cockerell.

THE Organisation and Management Committee of the Federation of British Industries, we are informed, has unanimously agreed to the formation of a new Main Group (No. 21) for cutlery, jewellery, electro-plate, and allied trades. They are to be divided into a number of sub-groups, including those for cutlery, manufacturing goldsmiths, silver and electro-plate manufacturers, and die-sinkers, stampers and piercers.

WILLENHALL IRONFOUNDERS' DINNER.—The annual dinner of the Willenhall and District Ironfounders' and Manufacturers' Association was held last week at the King's Hall Restaurant, Wolverhampton, the President (Mr. C. Retallack) being in the chair. In submitting the principal toast, Mr. Retallack said he believed that the organisation of the trade which they represented had been of untold benefit to Willenhall. They also knew their workpeople and their competitors, and things had gone along more satisfactorily. Councillor J. A. Harper replied. Mr. W. Osborne Wallis, in submitting the toast of "The President," expressed the hope he would continue to hold the reins until they had passed through these serious times. Mr. Arthur D. Tipper proposed the toast of "The Visitors," coupling the names of Mr. C. H. Pinson, Chairman of the Willenhall Council, Mr. A. E. Horst, president of the Walsall Association, Mr. F. J. Cook, chairman of Messrs. Rudge, Littley, Limited, West Bromwich, and Mr. W. A. Pepper. Each of these gentlemen responded.

XUM

Company News.

North Central Wagon, Limited.—Interim dividend for past half-year at rate of 12 per cent. per annum, less tax.

Lancashire & Yorkshire Wagon, Limited.—Interim dividend of 8s. per share, less tax, equal to 8 per cent. per annum.

Manchester Ship Canal Company, Limited. — Dividends of 10s. per share on the ordinary and preference shares, against 4s. 6d. and 9s.; forward, £44,309.

Normanby Iron Works, Limited.—Dividend of 6 per cent. on ordinary and preference shares for past half-year.

Scottish Wagon, Limited.—Net revenue for 1920 £19,745. Directors recommend further dividend, making 8 per cent., less tax, placing £4,500 to reserve, bringing it up to £86,000.

General Hydraulic Power, Limited.—Dividend for past half-year at rate of 5 per cent. per annum on preference, a final dividend on ordinary of 3½ per cent., less tax, and £9,913 forward.

Mond Nickel Company, Limited.—The directors have declared an interim dividend, to be paid on March 3, of 3½ per cent. on the cumulative and non-cumulative preference shares, less tax.

Frodair Iron & Steel, Limited.—Profit for year to June 30, including £599 brought forward, was £18,897. Dividend of 10 per cent. on ordinary, forward £10,434.

Penarth Harbour, Dock & Railway Company, Limited. — The directors purpose to pay a dividend to December 31 last at the rate of 5¼ per cent.

Sentinel Wagon Works (1920), Limited. — Profit from 1920 trading, after meeting all necessary charges, is £105,809; reserve, £25,000, applied in writing off preliminary expenses £9,263, and dividend on ordinary at rate of 10 per cent., less tax, carrying forward £8,211.

Leeds Forge Company, Limited.—An issue at 95 per cent. of 8 per cent. convertible debenture stock has been made, its object, it is stated, being mainly to provide the capital necessary for the purchase of the British Wagon and Carriage Works, Limited, and to furnish additional capital for the extension of the business of the company.

Allen-Liversidge Company, Limited. — Balance dividend of 7½ per cent. (less tax), making, with the interim dividend, 12½ per cent. for the year ended October 1, 1920, on shares Nos. 1 to 100,000 (against 11 per cent., for previous year), and half-year's dividend to October 31, 1920) at the rate of 12½ per cent. per annum (less tax) on shares Nos. 100,001 to 193,720 issued during 1920.

Deaths.

THE death is announced of Mr. George Nicholson (of the late firm of Nicholson & Waddeley, electrical engineers, Forth Street and Groat Market, Newcastle), who was engaged during the war by the military as chief engineer.

MR. JOHN ABBOT, who died at his residence, 4, Saville Place, Newcastle, on February 5, 1860, was formerly head of one of the best known of North-country ironworks, that of John Abbot & Company, Gateshead.

THE AMALGAMATED ENGINEERING UNION have decided to consult the Federation of Engineering and Shipbuilding Trades and its constituent unions before answering the suggestion of the National Union of Railwaymen that there should be arbitration to decide which body shall negotiate on behalf of railway shopmen in their wages demands.

SPEAKING at Chester recently, Mr. John Summers, chairman of John Summers, Limited, Harwarden Bridge Ironworks, Shotton, North Wales, said the present slackness of trade followed a period of false prosperity, which put inflated ideas into the heads of workers, who thought resources were illimitable. Until the falseness of the position was realised, there would be no getting business back.

A COURSE of three lectures on "The Human Element in Industry," is to be given in the Mappin Hall of the Sheffield University on Thursday afternoon next and the two following Thursday afternoons. Directors and managers of works are invited, and it is hoped that facilities will be granted for the attendance of the members of works' staffs. The lecturers are Dr. H. M. Vernon, and Messrs. Eric Farmer, M.A., and B. Muscio, M.A.

Personal News.

MR. JOHN GEORGE WILCOX, of Waterloo, engineer, left £12,077 (net personalty £11,914).

MR. JOHN H. B. NOBLE has been elected vice-chairman of Sir W. G. Armstrong, Whitworth & Company, Limited, and Mr. Alfred H. J. Cochrane has been made a director of the company.

HORSMAN & RUTHERFORD (Fred Horsman and Harold Rutherford), Brickfield Works, Holmfield, near Halifax engineers, have dissolved partnership. The debts will be paid by H. Rutherford.

MR. JOHN THOMAS DAVIES, of 6, Gwydr Gardens, Swansea, metal merchant, who died on December 6 last, left estate of the gross value of £24,618 5s 1d, with net personalty £19,450 9s. 5d.

MR. HERBERT AINSWORTH, late of Johannesburg, Transvaal, engineer and merchant, left property in the United Kingdom valued at £14,043, with net personalty of £12,792. He bequeathed £6,000 to Rossall School.

SIR THOMAS WILLIAMS, formerly general manager of the London and North-Western Railway, has been appointed a member of the Committee set up to inquire into, and advise the Minister of Transport on the question of the running by railway companies of road services for goods traffic.

MR. F. W. GIBBONS, J.P., chairman of the Welsh Plate and Sheet Manufacturers' Association, was entertained at a complimentary dinner of the steel and tinplate trades at the Hotel Metropole, Swansea, when he was presented with an illuminated address and a piece of solid silver plate in recognition of his long services to the Association and the tinplate trade.

JOHN I. THORNYCROFT & COMPANY, LIMITED.—The board has recently been enlarged by the election of technical directors and secretary of the company, and now consists of Sir John E. Thornycroft, K.B.E., M.I.N.A., managing director; Mr. S. W. Barnaby, M.Inst.C.E., M.I.N.A.; Sir Edwin Grant Burls, C.S.I.; Mr. T. Donaldson, M.Inst.C.E., M.I.N.A.; Mr. Alex Glegg, J.P.; Mr. J. Maughfling, C.A.; Mr. John Smith, M.I.N.A.; Mr. T. Thornycroft. The founder of the firm, Sir John I. Thornycroft, F.R.S., LL.D., continues his association with the company as Advisory Engineer and Naval Architect.

Gazette.

RICHMOND (SURREY) FOUNDRY, LIMITED. Mr. R. L. Tayler, 24, Coleman Street, E.C., was appointed receiver January 17.

ENGINEERS' PATTERN & GENERAL SUPPLY COMPANY, LIMITED, London, E.C.—Mr. R. H. Porter, Austin Friars House, E.C., was appointed receiver, January 21.

METAL INDUSTRIES, LIMITED, Sunbury-on-Thames (in voluntary liquidation). Meeting of creditors at the company's premises, Thames Street, Sunbury-on-Thames, February 4, at 11.

EASTON ENGINEERING AND CONSTRUCTION COMPANY, LIMITED.—Petition presented, January 31, by Rom River Company, Limited, 7, Beak Street, W. P. Thomas & Clark, 1 Bush Lane, E.C., solicitors. Mr. C. E. Penton, 15, New Broad Street, E.C., appointed receiver, January 25.

SHEFFIELD SCISSORS, RAZOR AND TOOL COMPANY, LIMITED.—Resolved January 19, confirmed February 3: That the company be wound up voluntarily. R. Hunt, Templeborough Works, Tinsley, Sheffield, liquidator. Meeting of creditors, at liquidator's, February 23, at 12. N.B.—The notice of meeting is formal. All creditors have been or will be paid in full.

SIMPLEX CONSTRUCTION COMPANY, LIMITED.—In the Chancery Division, Mr. Justice Astbury, on the motion of the Chemical Engineering Corporation, Limited, appointed Sir Arthur Whinneys as receiver and manager of the above company.

COLBY BROTHERS, LIMITED.—A largely-attended meeting of the creditors of Colby Brothers, Limited, shipbuilders and engineers, of Lowestoft, was recently held at the Institute of Chartered Accountants, Moorgate Street, E.C. The chair was occupied by Mr. F. D. Cooper, of Messrs. Cooper Brothers & Company, C.A., one of the liquidators in the voluntary liquidation of the company. The statement of affairs presented showed ranking liabilities of £120,517, while the assets were estimated at £215,812. From the latter amount had to be deducted £4,927 due on preferential claims and £50,000 for debentures. The net assets were, therefore, reduced to £160,884, or an apparent surplus of £40,367. A petition had been filed for the compulsory liquidation of the company. Voluntary liquidation had been decided upon because the debenture-holders (the bank) appointed a receiver. Eventually the creditors decided to confirm the voluntary liquidation of the company with the present liquidators, and a committee was also appointed.

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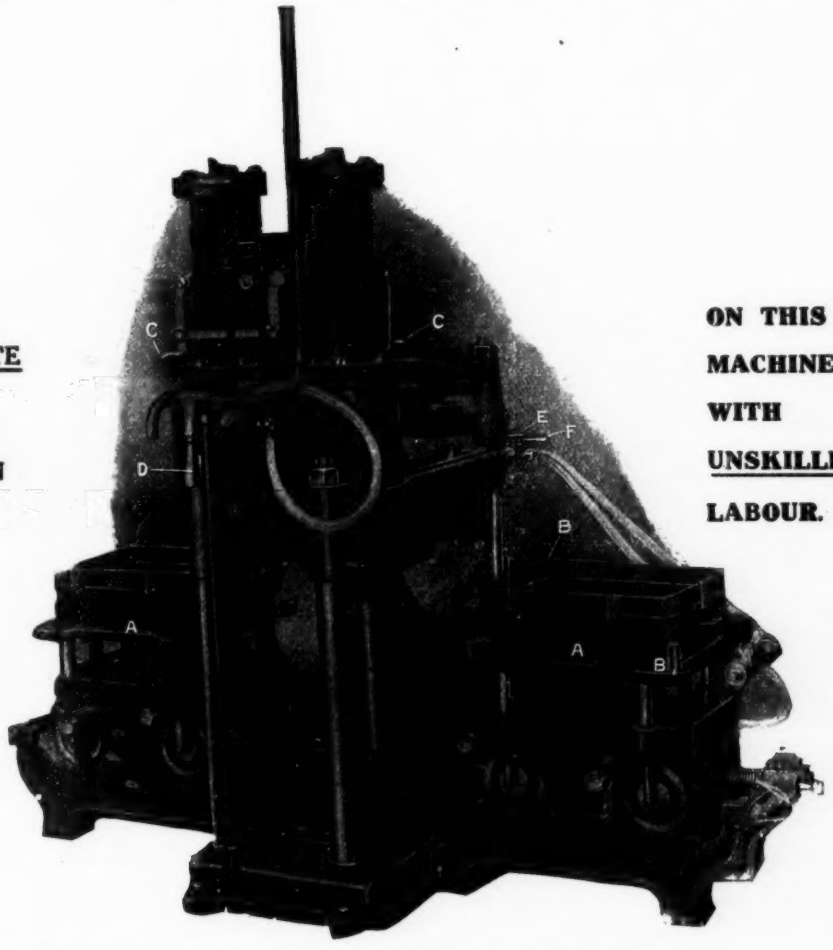

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IRON AND STEEL MARKETS.

Pig-Iron.

From all centres of the pig-iron smelting industry reports are practically unanimous, denoting only too clearly languishing demand, and a steady but sustained diminution of production at furnaces. As evidencing the present conditions of the trade as applying in the Midland area, it is reported that of 17 furnaces which are usually in blast in North Lincolnshire, there are now only six in operation. The absence of demand has necessitated this drastic curtailment of output. The North Lincolnshire Iron Company, Limited, has put out its last furnace, and the Redbourn Hill Iron and Steel Works are closed. The same story is repeated from Staffordshire, where numerous furnaces have ceased operations or have been damped down, smelters in many cases preferring to close works rather than entail a loss in producing. These conditions now extend also to Tees-side, where the pig-iron trade is more depressed than has been the case for some years past. Both ironmasters and merchants are experiencing an anxious time, with, so far, little prospect of relief from the prevailing gloom. To add to the difficulties of the position, home consumers are now being more and more favoured with attentions from Continental smelters, who can land their iron in local ports at prices which preclude competition, owing chiefly to the advantages conferred by the foreign exchanges. Consequently it is not only out of the question to book new business, but even consumers who place regular monthly orders are withdrawing from the market and makers, faced with the fact of rapidly accumulating stocks, are hastily taking steps to reduce consumption. The high cost of iron means the locking up of a considerable amount of dead capital if stocks are accumulated, and as there is little prospect of a future rise in prices to make the process profitable—rather, in fact, the reverse—makers are convinced that the only alternative is to boldly face the situation and lay idle the furnaces. There is, however, a fairly general impression that conditions in the iron trade will improve in the near future, and encouraged by that hope some Cleveland furnaces are merely being damped down, but others are actually being blown out, and there were rumours on 'Change of no fewer than nine more blast furnaces which are to be either damped down or blown out, thus reducing the number in blast on the North-East Coast to 61. Ironmasters have finally decided to withdraw the "rise and fall" clause, and sell on a fixed basis. It has not been found that the promise that consumers should benefit by any future fall in prices has stimulated buying, and as makers have now big stocks to dispose of which have been manufactured at high costs, they feel it desirable to do business on a fixed basis so as to be able to judge the extent of their commitments.

It is reported that whilst the demand for foundry iron is at a minimum, the recent reductions have improved the outlook in the East Coast hematite trade, and there is a prospect of better business both with Welsh consumers and also with clients abroad. Prices now rule as follow for East Coast mixed numbers, 220s., and No. 1 222s. 6d., both for home and export. In the Furness district, so far as Barrow is concerned, there is more activity to report in the hematite pig-iron trade, the Barrow Steel Company having put into operation four of the five furnaces recently damped down. This has been done, not on account of an access of business, but in order to complete contracts for which delivery is urgently wanted. Since last week there has been a further drop in prices, and now at Barrow mixed numbers of Bessemer iron are quoted at £11 per ton net, f.o.t. This is a substantial drop when compared with the December rate, which was £14 15s. per ton. Special iron is down to £12 10s. to £13 per ton. There is no business moving, however, just at present, although the hope is held out now that the difference as between buyers and sellers has been cut away, so that there will be a revival of trade.

Ore.

On the North-East Coast imports of foreign ore are still on a fairly substantial scale, but there has been little chartering of late, and practically no business in ore. Forty shillings per ton is now an average c.i.f. price for best rubia ore on the Tees, and the Bilbao freight is no more than 9s. 6d. per ton. The Furness iron mines resumed activity last week to meet the demand on local account. The Hodbarrow mines, however, continue closed down. Ore prices are again easier, with native sorts at 52s. 6d. to 70s. per ton net at mines, and Spanish ores reduced to 42s. 6d. per ton delivered.

Scrap.

In common with contemporary markets for pig-iron, the scrap trade generally is undergoing a very flat time, very little of this material changing hands at present, with the majority of consumers either fully stocked already, or bought in advance in sufficient volume for all probable requirements. Perhaps the only exception to an almost general rule is provided in the case of foundry scrap, consumers, in Lancashire especially, having still a fair amount of orders on hand, but still buying on this account is on an unusually restricted scale. Steel material is now literally a drug on the market, while only a limited demand is in evidence for wrought iron scrap. In South Staffordshire the scrap market is over-stocked, bar makers only taking wrought scrap in return for orders for bars, and with the tendency of business to the Continent, scrap has become something of a drug. Wrought iron scrap has been sold as low as £6, while heavy steel scrap can be bought for £4 10s.

Steel.

In most departments of the steel industry conditions remain without perceptible change, reports of idle mills and works in the chief centres of trade tending to monotonous repetition. The almost entire cessation of inquiries on overseas account will only partially explain the continued lethargy of business, for without question the needs for steel products are enormous and world-wide, and should in the ordinary course of events provide ample employment for mills, forges and foundries for many years to come. That the decline of trade is largely due to inflated prices is a generally accepted opinion in steel manufacturing circles, but the difficulty of finding a remedy is equally recognised, while costs of production are maintained at impossible levels by the high standard of values for both labour and fuel, the essential elements on which the quotable figures are based. Meanwhile the gradual deflation of prices of steel products continues in progress, the official prices recently fixed in Sheffield including Siemens' acid billets from £25 to £23 10s., and Bessemer acid billets from £24 to £23; also the basis price of bright drawn steel has been reduced from £35 to £33, and spring steel has eased 5 per cent. As these items of home consumption are, however, almost entirely free from foreign competition, the reductions have had little apparent effect in stimulating demand, but, on the other hand, the prospect of the crucible steel section is reported as slightly improved. Inquiries for this particular qualty of metal are said to be improved, and as it is probable that consumers and merchants stocks are becoming depleted, some increased activity of demand may be hopefully anticipated. This is encouraged by an interesting comparison of the steel and pig-iron exports of the United Kingdom and the United States respectively contained in a report prepared by the Trade Information Committee of the American Chamber of Commerce in London for American readers. British iron and steel exports have doubled since the war, declares the report, while those of the United States have fallen off by approximately 9 per cent. It is pointed out, however, that American exports of these products have increased since pre-war days, while those of the United Kingdom still stand at a lower figure than in 1913. An illuminating feature of the Board of Trade returns for January is reflected in the figures of our imports of iron, steel and manufactures thereof, particularly iron and steel from Belgium, which show a substantial increase. That country sent us 20,000 tons of billets. 13,500 tons of manufactured iron, and 3,000 tons of constructional steel. In addition we imported from various sources 6,000 tons of sheet bars and steel, 18,000 tons of plates and sheets, 5,000 tons of tubes, 2,000 tons of tram rails, 1,500 tons of iron and steel castings, and 4,600 tons of wire rods. In South Staffordshire the steel market is exceedingly inactive. English billets are not being inquired for owing to the necessity of reducing costs by taking advantage of Continental supplies at about £3 10s. cheaper. Business in constructional material is also going abroad. An attempt is being made to hold the steel bar trade, and to steady prices by a drastic revision. Prices of sheets are very irregular. There is only a slow demand for galvanised sheets, which are offered at £26 and less for 24-gauge corrugated, from stock. Most of the mills are closed down. Industrially there is more activity to report in the steel trade at Barrow. Last week the Siemens' department and the foundries were once more working, and other branches may go on later. As in the case of the blast furnaces this is only temporary, unless favourable circumstances should develop, and it is not known how long the run will go on. The hoop mills are busily employed. Steel is in very slow demand all round.

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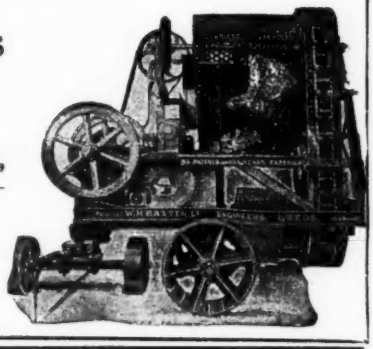

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Finished Iron.

Markets for all descriptions of finished material continue in a practically lifeless condition, neither sellers nor buyers making an attempt at actual business, while export trade is also stagnant. The position affords little prospect so far of an early revival of activity, and it is to be feared our Continental trade rivals in their price-cutting campaign are securing any business going either in home or overseas markets. In Scotland, however, some hopes are entertained that the removal of the Excess Profits Duty may give a much needed stimulus to business. Clydeside firms are said to be in receipt of more inquiries than for a long time past. Export houses are encouraged by the Chancellor's hint of protection from dumping, and business contracts long held up are now likely to be pushed forward. The men's leaders suggest that the unions must now play for time and await improved trade. In South Staffordshire recent reductions in prices of marked bars has had, as yet, very little beneficial effect on trade as a whole, but makers of this material are in a more favourable position than others, but with a declining demand for chain and cable and agricultural implement manufactures, fresh orders are not coming forward in such volume as was previously the case. In the section producing unmarked bars, mills are reported either idle or running on short time, and though the price of Staffordshire brands is nominally £26 10s, complaints of under-cutting are made. In this market Belgian bars are firmer at £16 to £16 10s, owing to the variation in the exchange rate, and users have large stocks bought at even lower prices. Iron strip, one of the last branches to feel the prevailing slackness, is quoted £29 10s. There has been so far no change in the Lancashire bar-iron market, but the lower price does not seem to have encouraged buying to any great extent.

Refractories.

There has been a general falling off in the demand for refractories during the last week, and the apparent reason for this is that most of the users have good stocks, and are refraining from ordering owing to the uncertain position of trade just now. The demand for steel and iron foundry sands shows no improvement, but the inquiry for steel moulders' composition is fairly constant. The outstanding feature of the market at present is the demand for magnesite bricks and magnesite, prices remaining firm at the figures quoted in our last issue.

Tinplates.

A slightly more encouraging outlook is reported in the Welsh tinplate trade, though business is still exceedingly scarce. The recent reduction in steel bars of £3 per ton to £14 10s., and the coming abolition of the Excess Profits Duty, has induced an improvement that conditions will eventually right themselves. At the same time there is a consensus of opinion that prices will have to be reduced materially before any substantial revival in trade can be expected. Ternes are quiet, and wasters are dull. There is a fairly plentiful supply of oil sizes in stock in the latter section. Quarter wasters are on offer at 22s. to 23s. per box, and 28 x 20's 25s. to 26s. f.o.t. Current prices ruling are:—Cokes, 20 x 14, 32s., 36s.; quarters, 36s., 37s. 6d.; cokes, 20 x 10, 50s., 51s.; ditto, 28 x 20, 66s., 72s.; ternes, 28 x 20, 70s., 72s.

Metals.

Copper.—The markets for copper opened this week with an easier tone, but subsequently developed some strength consequent upon a more active inquiry on consumer's account, especially for forward metal. The recovery in values, however, was only temporary, and the close of the market showed a fractional loss on the day both for prompt and forward positions. Closing prices:—Cash: Wednesday, £72; Thursday, £71; Friday, £71 7s. 6d.; Monday, £71; Tuesday, £71 12s. 6d. Three Months: Wednesday, £72 10s.; Thursday, £72 5s.; Friday, £71 15s.; Monday, £71 7s. 6d.; Tuesday, £71 12s. 6d.

Tin.—Opening this week with more favourable Eastern advices, the market for tin evidenced considerable reserve on the part of sellers, and values steadily appreciated both for prompt and forward account. Firmness also developed in other sections, Straits being quoted £192, Banca £197, and Australian £185, bars £169 to £170, and refined £172.—Closing prices:—Cash: Wednesday, £161 15s.; Thursday, £165; Friday, £168; Monday, £172; Tuesday, £170 5s. Three Months: Wednesday, £167 5s.; Thursday, £170; Friday, £172; Monday, £175 10s.; Tuesday, £173 10s.

Spelter.—With a disappointing inquiry from consumptive interests, values for spelter showed a weaker tendency, and at the close marked a fractional loss, ordinary brands prompt closing £24 17s. 6d., English £27 10s.

Lead.—On freer offerings of sellers prices for lead receded, good brands of soft pig, near dates closing 10s. and forward 7s. 6d. lower, with February quoted £21 10s., March £21 to £21 5s., April £21 5s. to £21 7s. 6d., and English unchanged at £23.

DO YOU REQUIRE **CASTINGS** From 1 cwt. to 2 tons each?
The NORTHGATE IRONWORKS Co.
(Proprietors, R. Boby, Ltd., Associated with Vickers, Ltd.),
RAIL SIDING, BURY ST. EDMUNDS, SUFFOLK.
Finest Modern Foundry in the Eastern Counties.
Speciality: MACHINE MOULDING.
PROMPT DELIVERIES.
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HARRIS BROS.
(Late PETER HARRIS),
Metal Brokers, Mineral Agents, and Carriers.
BRIERLEY HILL, STAFFORDSHIRE.

CASTINGS MADE RUSTLESS
Write for Particulars.
The Rustless Iron Co., Ltd.,
Trico Works,
KEIGHLEY.

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RBW
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Manufacturers of
WIRE, - WIRE NETTING, WIRE ROPE, NAILS, etc.
PRICES ON APPLICATION.

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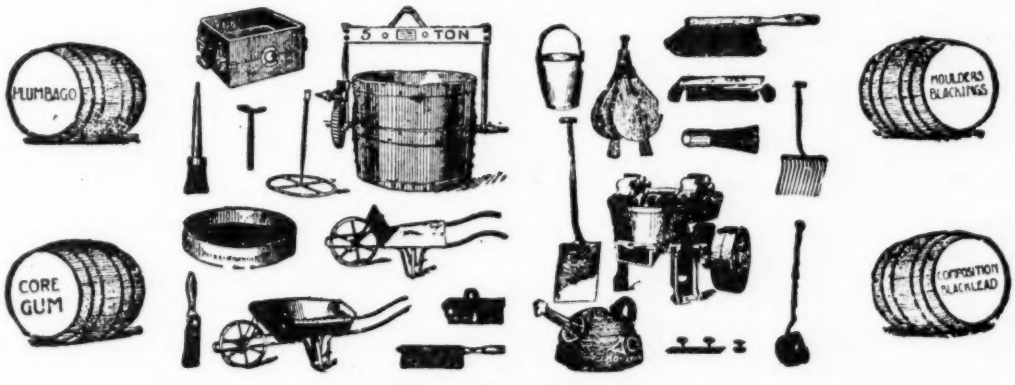
Established 1863.

JAS. DURRANS & SONS,

Phœnix Works, Penistone, Near Sheffield.



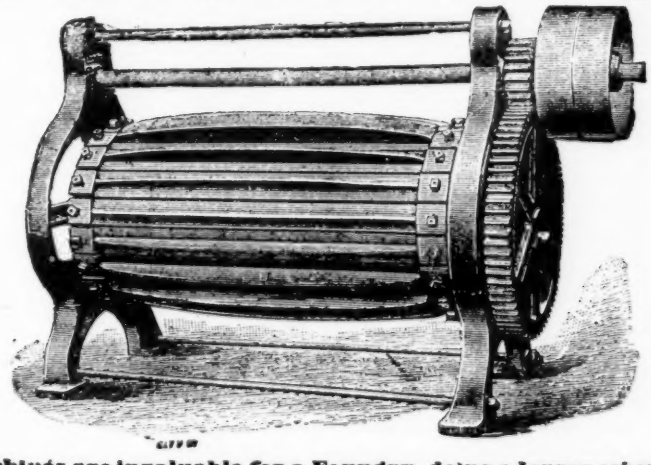
Manufacturers of all

FOUNDRY EQUIPMENTS

COMPOSITION BLACK LEAD, PLUMBAGO, CORE GUM, WHITE DUST & COAL DUST

Ladles, Cupolas, Fire Bricks, Gannister, Stone Flux, Loam and Sand Mills, Casting Cleaners, Studs, Chaplets, Pipe Nails, Sprigs, Brushes, Wire Brushes, Core Ropes, Bellows, Buckets, Spades, Forks, Riddles, Sieves, Barrows, Etc.

Improved Foundry Rattler or Fettling Drum.



These Machines are invaluable for a Foundry, doing a larger amount of work of a superior quality, in a much shorter time than can be done by hand, without skilled labour.

The following testimonial explains itself :—

"Dear Sirs,—We have been using your best Blacking for a large number of years, and always use it on our large Ingot Moulds, which, as you know, we have made up to 85 tons in weight.

Yours faithfully, THE BRIGHTSIDE FOUNDRY & ENGINEERING CO., LD.

WEEKLY PRICE CURRENT.

COPPER.

	£	s.	d.
Standard cash	71	12	6
Three months	71	12	6
Electrolytic	77	10	0
Tough	75	0	0
Best selected	75	10	0
Sheets	124	0	0
India	124	0	0
Wire bars	78	10	0
Do. Mar.	78	0	0
Do. April	78	0	0
Ingot bars	77	10	0
H.C. wire rods	85	0	0
Off. aver. cash, Jan.	71	1	4⅜
Do. 3 mths., Jan.	71	9	4⅝
Do. Settlement Jan.	71	0	2⅜
Do. Electro, Jan.	80	3	1½
Do. B.S., Jan.	77	13	9
Aver. spot, copper, Jan.	70	19	9½
Do. Electro, Jan.	81	3	8¾
Solid drawn tubes			17d.
Brazed tubes			17d.
Wire			14½d.
Yellow metal rods			9½d.
Do. 4x4 Squares			12d.
Do. 4x3 Sheets			12d.

BRASS.

Solid drawn tubes	14¾d.
Brazed tubes	17¾d
Rods	13¾d.
Sheets to 10 w.g.	13d.
Wire	12¾d.
Rolled metal	12¼d.

TIN.

	£	s.	d.
Standard cash	170	5	0
3 Months	173	10	0
English	167	0	0
Bars	169	0	0
Chinese	165	0	0
Straits	192	0	0
Australian	185	0	0
Eastern	203	0	0
Banca	197	0	0
Off. aver., cash, Jan.	190	13	11½
Do. 3 mths., Jan.	195	18	11½
Do. Sttlment., Jan.	190	10	0
Aver. spot, Jan.	190	9	6¼

SPELTER.

	£	s.	d.
Ordinary	24	17	6
Remelted	20	0	0
Hard	18	0	0
Electro 99.9	34	15	0
English	27	10	0
India	21	15	0
Prime Western	26	0	0
Zinc dust	60	0	0
Zinc ashes	6	5	0
Off. aver., Jan.	25	15	7½
Aver., spot, Jan.	25	5	5¾

LEAD.

	£	s.	d.
Soft foreign ppt	20	10	0
English	23	0	0
Off. average, Jan.	23	12	6⅝
Average spot, Jan.	23	7	8¾

ZINC SHEETS.

	£	s.	d.
Zinc sheets, spot	39	0	0
Do. V.M. ex. whf	39	0	0
Do. ppt., f.o.b., N.Y.			—
Dutch	38	10	0
Boiler plates	36	0	0
Battery plates	35	0	0

ANTIMONY.

	£	s.	d.
English regulus	37	5	0
Special brands	42	0	0
Chinese	24	0	0
Crude	20	0	0

QUICKSILVER.

	£	s.	d.
Quicksilver	12	5	0

FERRO-ALLOYS AND STEEL-MAKING METALS.

Ferro-silicon—	
45/50%	£19 0 0
75%	£28 10 0
Ferro-vanadium—	
35/40%	28/- lb. va.
Ferro-molybdenum—	
70/80%	7/9 lb. mo.
Ferro-titanium—	
23/25%, carbonless	1/6 lb.
Ferro-phosphorus, 20/23%,	£49
Ferro-tungsten—	
80/85%, carbon low	2/- lb.
Tungsten metal powder—	
98/99%	3/1 lb.
Ferro-chrome—	
4/6% car.	£37 10
6/8% car.	£37
8/10% car.	£36 10
Ferro-chrome—	
Max. 2% car.	£87
Max. 1% car.	£104
Max. 0.75% car.	£120
65/75%, carbonless	3/- lb.
Nickel—99·8%, cubes or pellets	£210
Cobalt metal—97%	20/- lb.
Aluminium—98/99%	£165
Metallic Chromium—	
98/99%	7/6 lb.
Ferro-manganese—	
76/80%, loose	£28
76/80%, packed	£29
76/80%, export	£28
Metallic manganese—	
98/99%, carbonless	3/6 lb.
Per ton unless otherwise stated.	

HIGH-SPEED TOOL STEEL.

Finished bars, 14% tungsten	s. d. 3 2
Finished bars, 18% tungsten	4 0
Scrap pieces	5d.
Turnings and swarf	3d.
Per lb. net, d/d buyers' works.	
Extras—	
Rounds and squares 3 in. to 8 in. inclusive	4d. lb.
Rounds and squares under ½ in. to ¼ in.	3d. lb.
Flats under 1 in. by ⅜ in. to ½ in. by ¼ in., and all sizes over four times in width over thickness	3d. lb.
Bevels of approved sizes and sections	6d. lb.
If in coils	3d. lb.
Packing	4s. cwt
Bars cut to length 10% extra	
Scrap from high-speed tool steel—	
Scrap pieces	5d.
Turnings and swarf	3d.
Per lb. net, d/d steel makers' works.	

SCRAP.

	£	s.	d.	£	s.	d.
South Wales—						
Heavy Steel				5	0	0
Bundled steel & shearings				4	10	0
Mixed iron & steel	2	0	0	5	0	0
Heavy cast iron				6	0	0
Good machinery for foundries				9	10	0
Cleveland—						
Heavy steel				5	0	0
Steel turnings				4	7	6
Steel borings				4	2	6
Heavy wrought iron piling				7	15	0
Bundling scrap				7	5	0
Cast-iron scrap				9	10	0
Lancashire—						
Cast iron scrap				9	5	0
Heavy wrought				6	0	0
Steel turnings				3	15	0
London—						
Copper (clean)				55	0	0
Brass (clean)				35	0	0
Lead (less usual draft)				18	10	0
Tea lead				16	10	0
Zinc				12	10	0
New aluminium cuttings				90	0	0
Braziery copper				45	0	0
Gun metal				48	0	0
Hollow pewter				120	0	0
Shaped black pewter				80	0	0

PIG-IRON.

N.-E. Coast—	
Foundry No. 1	200/-
Foundry No. 3	195/-
Forge No. 4	194/-
Mottled	192/6
Hematite No. 1	222/6
Hematite M/Nos.	220/-
Midlands—	
Staffs. common	195/-
,, part-mine forge	235/-
,, ,, foundry	240/-
,, Cold blast	360/-
,, basic	195/-
Northants forge	217/6
,, foundry No. 3	230/-
,, basic	205/-
Derbyshire forge	225/-
,, foundry No. 3	235/-
,, basic	230/-
Scotland—	
Foundry No. 1	235/-
,, No. 3	230/-
Hematite M/Nos.	230/-
Sheffield (d/d district)—	
Derby forge	—
,, foundry No. 3	—
,, basic	—
Lincs. forge	215/-
,, foundry No. 3	220/-
,, basic	187/6
E.C. hematite	233/-
W.C. hematite	240/-
All d/d in the district.	
Lancashire (d/d eq. Man.)—	
Derby forge	—
,, foundry No. 3	—
Northants foundry No. 3	—
Cleveland foundry No. 3	—
Staffs. foundry No. 3	—
Lincs. forge	—
,, foundry No. 3	—
Summerlee foundry	—
Glengarnock foundry	—
Gartsherrie foundry	—
Monkland foundry	—

FINISHED IRON & STEEL.

Iron—	£	s.	£	s.	d.
Bars (cro'n)	24	0	26	10	0
Angles	24	10	27	0	0
Tees to 3 united ins.	25	0	27	10	0
Nut and bolt			26	10	0
Hoops			26	5	0
Marked bars (Staffs.)			29	10	0
Gas strip			29	10	0
Bolts and nuts, ¾ in. × 4 in.			51	0	0
Steel—					
Ship plates			22	10	0
Boiler plates			29	0	0
Checquer plates			25	10	0
Angles			21	0	0
Tees			22	0	0
Channels			21	10	0
Joists			21	0	0
Rounds, ½ in.–3-in.			21	0	0
Rounds, 3 in.–5½ in.			20	0	0
Flats, 5 in.–8 in.			20	10	0
Flats over 8 in.			20	0	0
Rails, heavy			21	0	0
Fishplates			27	0	0
Hoops			23	0	0
Black sheets, 24 g.			24	10	0
Galv. cor. sheets, 24 g.			26	0	0
Galv. fencing wire, 8 g. plain			30	10	0
Rivets, ¾ in. dia			36	0	0
Billets, soft			13	10	0
Billets, hard			14	10	0
Sheet and tin bars			14	10	0

PHOSPHOR BRONZE.

Rolled.	Per lb. s. d.
⅛ in. to 1 in. wide	2 0½
1 in. to 1½ in. wide	1 11½
1½ in. to 2 in. wide	1 10½

Strips.	s. d.
2 in. to 6 in. to 26 S.W.G.	1 9½
6 in. to 12 in. to 26 S.W.G.	1 9½
Sheets.	s. d.
12 in. to 18 in. to 24 S.W.G.	1 10
18 in. to 24 in. to 24 S.W.G.	1 10½
24 in. to 30 in. to 20 S.W.G.	1 11½
30 in. to 36 in. to 16 S.W.G.	2 0½
36 in. to 42 in. to 16 S.W.G.	2 1½

Extras.

For Gauge: Any width up to 36 in. wide, ½d. per lb. per thinner gauge.

Drawn Rods.	s. d.
¼ in. to ½ in. dia. in random lengths / ⅝ in. to 1½ in. dia. in random lengths	1 10½
Over 1½ in. to 1¾ in.	1 10½
Tubes—basis price	2 0½

Delivery 2 cwt. free to any town.

10% phosphor copper, £40 above price of B.S.

15% phosphor copper, £50 above price of B.S.

Phosphor tin (5%), £30 above price of English ingots.

Charles Clifford & Son, Limited, Birmingham.

NICKEL SILVER, SHEET METAL, WIRE AND TUBES.

	Per lb.
Ingots for raising	1/3 to 1/9
Rolled—	
To 9 in. wide	1/10½ to 2/4½
To 12 in. wide	1/11 to 2/5
To 15 in. wide	2/– to 2/6
To 18 in. wide	2/1 to 2/7
To 21 in. wide	2/2 to 2/8
To 24 in. wide	2/3 to 2/9
Ingots for spoons and forks	1/3 to 1/9
Ingots rolled to spoon size	1/6 to 2/–
Wire round—	
3/0 to 10. G.	2/1 to 2/8

with extras according to gauge.

AMERICAN IRON & STEEL.

At Pittsburgh unless otherwise stated.	Dols.
No. 2X foundry, Phila.	32.09
No. 2 foundry Valley	30.00
No. 2 foundry, Birm.	27.50
Basic	30.96
Bessemer	33.96
Malleable	33.96
Grey forge	30.96
Ferro-manganese, Atlport	100.00
Bess. rails, h'y, at mill	45.00
O.-h. rails, h'y, at mill	47.00
Bess. billets	43.50
O.-h. billets	43.50
O.-h. sheet bars	47.00
Wire rods	57.00
	Cents.
Iron bars, Phila.	2.70
Steel bars	2.35
Tank plates	2.65
Beams, etc.	2.45
Skelp, grooved steel	2.45
Skelp, sheared steel	2.65
Steel hoops	3.05
Sheets, black, No. 28	4.35
Sheets, galv., No. 28	5.70
Sheets, blue an'l'd, 9&10	3.55
Wire nails	3.25
Plain wire	3.25
Barbed wire, galv.	4.10
Tinplate, 100-lb. box	$7.00

COKE.

Welsh foundry	72/6
,, furnace	57/6
Durham & North foundry	70/–
,, furnace	54/6
Other Districts, foundry	77/9
,, furnace	55/–

SWEDISH IRON.

Bars, hammered basis sizes ..	Basis price. £ s. d.
Rolled Ordinary—Assortment ..	31 0 0 to 38 0 0
Nail Rods—Square, round and flats ..	
Keg Steel } about Faggot Steel } £50	Prices nominal.
Blooms—Single welded ..	£20 to £25
Billets—Single and double welded ..	£22 to £27
Pig-Iron—Grey, white or mottled ..	£15 to £20

Prices are without engagement. All quotations are f.o.b. Gothenburg, net cash against documents there.

TUBES.

	Up to and incl. 2 in.	Over 2 in.
Gas ..	net	−5%
Water ..	+10 %	+ 3¾%
Steam ..	+21¼%	+13¾%

REFRACTORIES.

	£	s.	d.
Magnesite bricks, 2½ in., d/d	137	10	0
Do. 3 in., d/d	165	0	0
Common firebricks, 2½ in., d/d	10	0	0
Do. 3 in., d/d	12	0	0
Scotch firebricks, 2½ in., f.o.r.	12	15	0
Do. 3 in., f.o.r.	15	7	6
Sheffield quality, 2½ in., f.o.r.	11	0	0
Do. 3 in., f.o.r.	13	5	0
Silica bricks (ord.), 2½ in., f.o.r.	15	10	6
Do. 3 in., f.o.r.	18	12	6

All per 1,000 bricks.

Basic Dolomite ..	3	18	0
Dead burnt magnesite (peas and powder), d/d ..	26	0	0
Ground fireclay	1 10	0 to 2	0 0
Ganister	1 10	0 to 1	12 6

TINPLATES.

I.C. Cokes, 20×14, box	33/-
,, 28×20, ,,	66/-
,, 20×10, ,,	47/-
,, 18¾×14, ,,	36/-
Terneplates, 28×20, ,,	70/-

DAILY FLUCTUATIONS.

Standard Copper (cash).

	£	s.	d.	
Feb. 9	72	0	0	No change
,, 10	71	15	0	dec. 5/-
,, 11	71	7	6	,, 7/6
,, 14	71	0	0	,, 7/6
,, 15	71	12	6	inc. 12/6

Standard Tin (cash).

Feb. 9	161	15	0	dec.	45/-
,, 10	165	0	0	inc.	65/-
,, 11	168	0	0	,,	60/-
,, 14	172	0	0	,,	80/-
,, 15	170	5	0	dec.	35/-

Zinc Sheets (spot).

Feb. 9	39	0	0	No change
,, 10	39	0	0	No change
,, 11	39	0	0	No change
,, 14	39	0	0	No change
,, 15	39	0	0	No change

Spelter (ordinary).

Feb. 9	25	15	0	inc.	10/-
,, 10	26	0	0	,,	5/-
,, 11	25	15	0	dec.	5/-
,, 14	24	10	0	,,	25/-
,, 15	24	17	6	inc.	7/6

Lead (English).

Feb. 9	24	0	0	dec.	10/-
,, 10	23	15	0	,,	5/-
,, 11	23	0	0	,,	15/-
,, 14	23	0	0	No change	
,, 15	23	0	0	No change	

SHROPSHIRE IRON Co., Ltd.

Works:—
Hadley, Shropshire.

London: 10, Bush Lane, Cannon St., E.C.4.

Telegrams:—
Sun, Wellington, Salop.
Sunbrand (Cannon), London.

Telephone:—
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5959 Central.

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in IRON, STEEL, COPPER and BRONZE.

Galvanised Telegraph, Telephone, Cable and Trolley Wire
To all Specifications.

Contractors to H.M. Government (Admiralty, G.P.O., India Office, War Office, Colonies), English and Foreign Railways, &c.

BEST H. C. COPPER & BRONZE WIRE a speciality.

Medals:—Sydney (Bronze) 1879, New Zealand (Gold) 1882, Liverpool (Silver) 1886, Adelaide (Gold) 1887, Franco-British Grand Prix (Highest Award) 1908.

ROBERT HEATH & LOW MOOR, LIMITED,
Stoke-on-Trent.

B.B.H. IRON.
At works.
BARS, ANGLES, TEES and PLATES.

R.H. ✪ IRON.
Delivered F.O.B. Liverpool.
BARS, ANGLES, TEES and PLATES.

HOOPS delivered F.O.B. Liverpool.

IRON
R.D. ✪
RAVENSDALE (Best)

MILD STEEL (up to 2in. wide)
Marked
"HEATH'S SOFT STEEL."

Prices on Application.

WILLIAM JACKS & COMPANY,
5, EAST INDIA AVENUE, LONDON, E.C.3.

Telegrams: ALKALIZE, BIRMINGHAM.
Telephone: CENTRAL 1175 & 1176
Birmingham Office:
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Telegrams: ALKALIZE, LONDON.
Telephone: 7880 AVENUE (3 lines.
Head Office:
5, EAST INDIA AVENUE, London, E.C.

REGISTERED TRADE MARK

PIG IRON.

Scotch, Middlesbro,' Hematite, Basic, Specials, &c., &c.

TIN — SPELTER — CHROME
COPPER — ANTIMONY—MANGANESE.

WILLIAM COLVIN & COMPANY,

ROYAL EXCHANGE.
MIDDLESBROUGH.

93, HOPE STREET,
GLASGOW.

SITUATION WANTED.

FOUNDRY FOREMAN, 24 years' experience iron and non-ferrous metals, dry sand and loam, machine and plate moulding; last position Assistant Foundry Manager, first-class testimonials. Will accept position as Working Foreman.—A. B. SMITH, 24, Field Lane, Teddington.

AGENCY.

LONDON AND EXPORT TRADE.—A firm of Engineers, with unique connections at home and abroad, having excellent offices in best part of Westminster, London, have vacancy in their organisation for representation of manufacturing engineering concern desiring to increase trade. Exceptional opportunity.—Apply, Box 620, Offices of the FOUNDRY TRADE JOURNAL, Bessemer House, 5, Duke Street, Adelphi, London, W.C.2.

MISCELLANEOUS.

LIMESTONE, Raw for Blast Furnaces, etc. Finest Quality.—Prices from KNOWLE LIME WORKS, Presthorpe, Salop.

STRONG ERITH FOUNDRY LOAM on Rail in Truck loads.—Sample and quotation from T. C. BUCKLEY, Sand Pits, Erith.

WANTED all users of METALLIC CEMENT to buy our PEERLESS brand, which produces "Artificial Iron" 10 lb. tin 10s., free delivered.—WILLIAM OLSEN, LTD., Cogan Street, Hull.

IN LIQUIDATION.—Rockingham Ironfoundry Co., Ltd., Cotton Road, Nuneaton. The assets of the above company are for sale.—Full particulars can be obtained from C. R. MILES, 20, Friar Lane, Leicester, Liquidator.

PATTERNS SUPPLIED WHICH GIVE SATISFACTION. Inquiries solicited. Quotations by return of post or telephone. You can secure good-class work, reasonable prices, and promptitude in delivery by placing your orders with VIDEX ENGINEERS' PATTERN WORKS, 22, Huntsworth Mews, Upper Baker Street, London, N.W.1 (Telephone, Paddington 364).

ADVICE and Handbook Free.—KING'S PATENT AGENCY, LIMITED, Director, B. T. King, Reg. Patent Agent, 146a, Queen Victoria Street, E.C.4.

WANTED, immediately, 2,000 ft. .937 Hex. across flats bright mild steel. State lowest price and delivery.—Box 672, Offices of the FOUNDRY TRADE JOURNAL, Bessemer House, 5, Duke Street, Adelphi, London, W.C.2.

THE Standard Minerals Co. supply at lowest prices Foundry Coke, Purified Breeze, Ganister, Fire Clay and Bricks, Limestone, Spar, and Moulding Sand to suit all requirements.—THE STANDARD MINERALS CO., 136-138, Mansfield Road, Nottingham.

FOUNDRY REQUISITES.—Straw Rope, Core Gum, Core Vent, Plumbago, Blacking, Coal Dust, Riddles, Sieves, Bellows, etc. Prompt delivery. Lowest prices.—LYNDHURST MANUFACTURING CO., 25, Sherwood Rise, Nottingham.

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MACHINERY.

TURN TO THE B.W.S. ANNOUNCEMENT, PAGE 12.

FOR SALE.—5 ft. 6 in diameter Drop Bottom Cupola (Thwaites), complete with 20-cwt. Electric Hoist and Charging platform; quite new, never been used.—R RUSSELL & SONS, LIMITED, Derby.

FOR SALE.

Two 6-WHEEL 12-in. x 18-in. LOCOMOTIVES (Manning Wardles), 4 ft. 8½ in. gauge, both thoroughly overhauled and in first-class condition, and suitable for 140 lbs. steam w.p.

4-WHEEL 8 in. x 14 in. LOCOMOTIVE (Manning Wardle), 4 ft. 8½ in. gauge, 140 lbs. w.p.

2-TON LOCO. STEAM CRANES (Appleby), with 20-ft. steel lattice derricking jib; three-motor type; 4 ft. 8½ in. gauge; 9 ft. wheel-base.

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